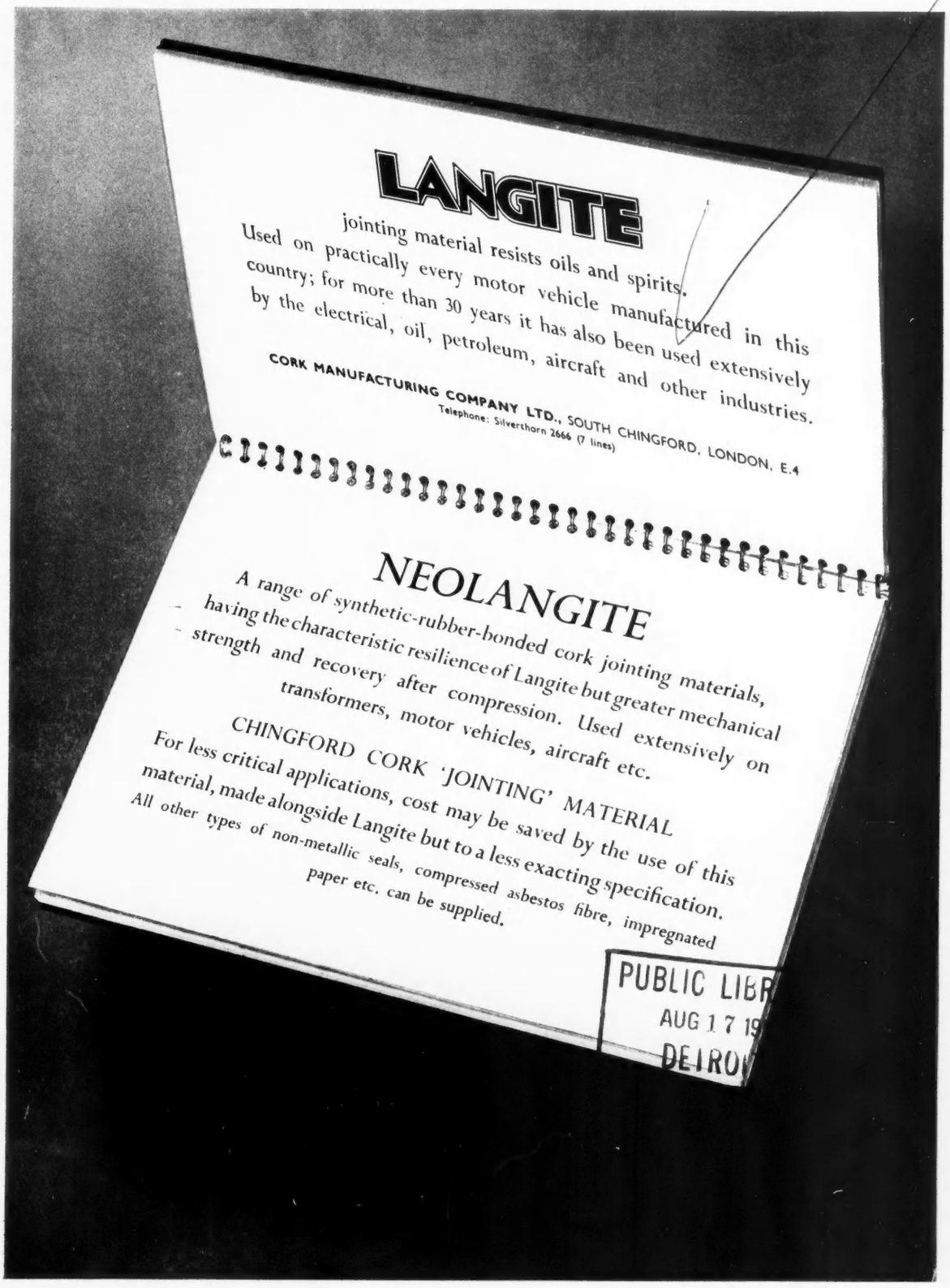
TECHNOLOGY DEPT.

The Engineer

AUGUST 2, 1957 28 ESSEX ST., STRAND, LONDON, W.C.2 TWO SHILLINGS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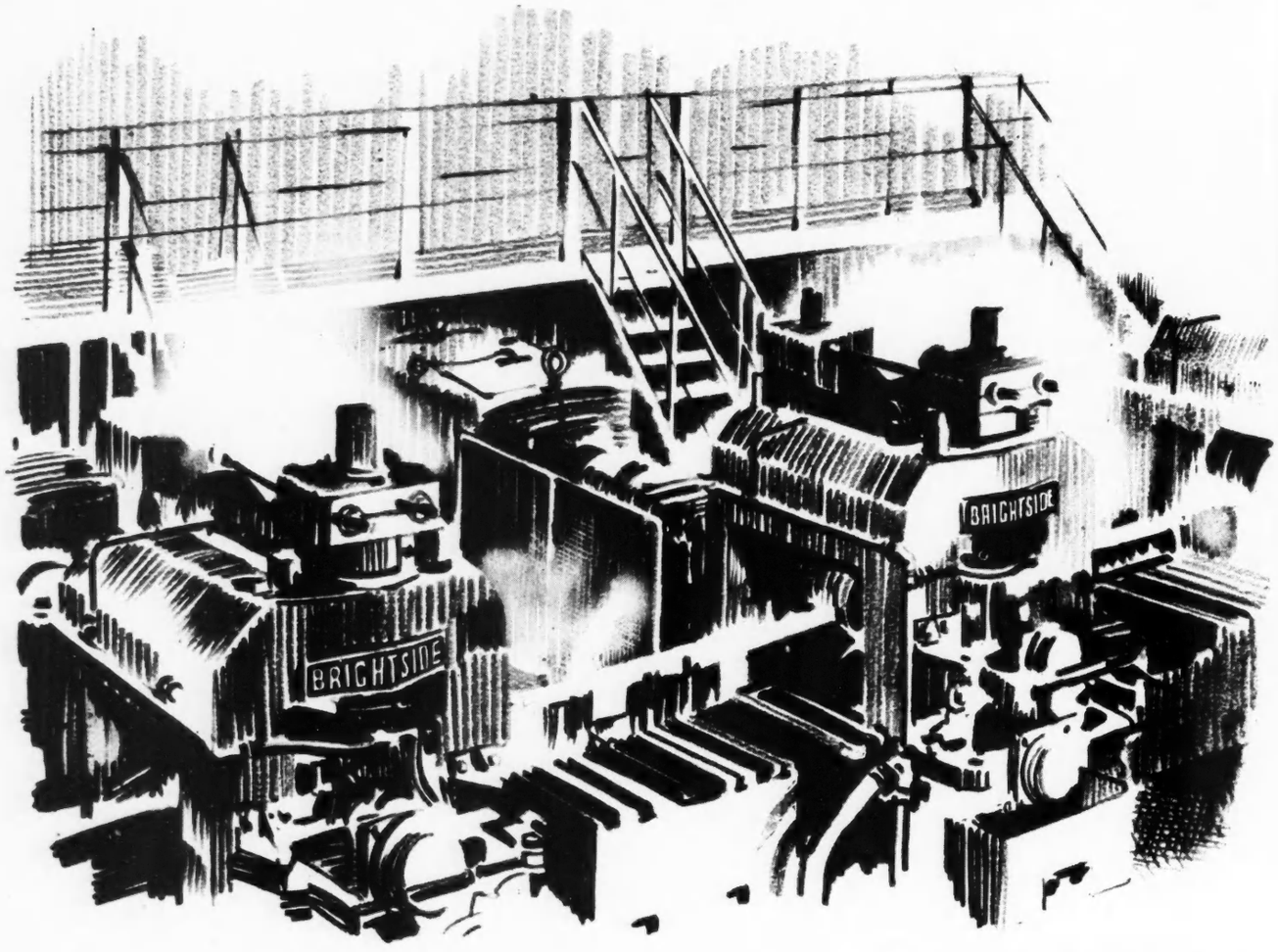
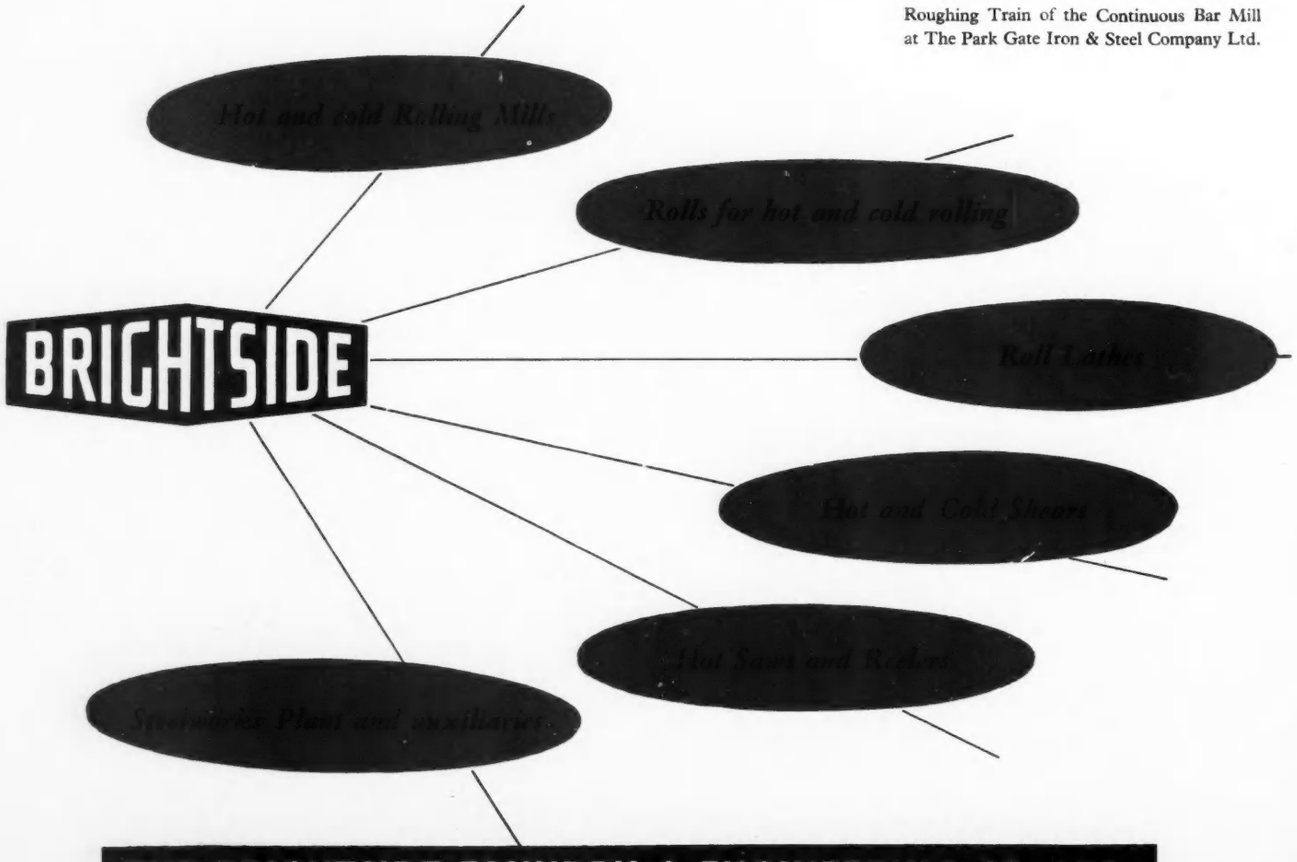


Roughing Train of the Continuous Bar Mill
at The Park Gate Iron & Steel Company Ltd.



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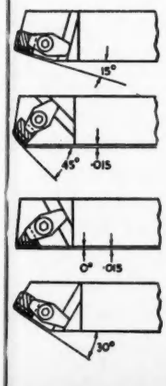

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THE ENGINEER

ESTABLISHED 1856

28 ESSEX STREET, STRAND, LONDON, W.C.2.

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NOTICE TO READERS

All letters intended for insertion in "The Engineer" or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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PUBLIC APPOINTMENTS

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

BRUNEL COLLEGE OF TECHNOLOGY, WOODLANDS AVENUE, ACTON, W.3.

HEAD OF DEPARTMENT

This College is to open in new buildings in September, 1957, and will take over the advanced work of Acton Technical College.

Applications are invited for the HEADSHIP of the following department, which will be a Grade IV department :

MECHANICAL ENGINEERING.

Candidates should be highly qualified and have suitable industrial and/or research experience, and preferably some full-time and/or part-time university or technical lecturing experience.

There is an opportunity to build up new departments and to develop sandwich courses for the diploma in technology, post-graduate technological courses and research.

Salary in accordance with the Burnham (Technical) Report, 1956, i.e. £1750 by £50 to £1900 plus London allowance.

Further particulars and application forms (stamped addressed fooscap envelope) from the Clerk to the Governing Body, Middlesex County Council, Education Department, 10, Great George Street, Westminster, S.W.1, to whom completed forms should be returned by 16th August, 1957.

C. E. GURR, M.Sc., Ph.D.,
E7788 Secretary to the Education Committee.

UNIVERSITY OF BIRMINGHAM

LECTURESHIPS IN MECHANICAL ENGINEERING

Applications are invited for TWO LECTURESHIPS in MECHANICAL ENGINEERING. Candidates should have an Honours Degree in Engineering and either (1) experience in machine design and drawing-office practice, or (2) an interest in research, together with experience in the fields of heat transmission and/or the compression-ignition engine. Salary £900–£1650 p.a., according to qualifications.

Applications (two copies) should be sent before August 31st, 1957, to the Deputy Registrar, The University, Birmingham, 15, from whom further particulars can be obtained. E7769

PUBLIC APPOINTMENTS

SINGAPORE POLYTECHNIC

APPOINTMENTS

The Board of Governors invite applications for the following posts :—

SENIOR LECTURER IN ELECTRICAL ENGINEERING : University Graduate and/or A.M.I.E.E. with good teaching and industrial experience. The department is expected to provide courses of the O. and H.N.C. and/or Diploma type and City and Guilds courses in Installations, Electrical Engineering Practice, Radio and Telecommunications.

SENIOR LECTURER IN MACHINE SHOP ENGINEERING : good practical experience, including apprenticeship and qualifications such as a City and Guilds Final Certificate, A.M.I.Prod.E. or their equivalent. Should be able to supervise a metrology laboratory and other workshop courses such as Welding and Motor Engineering.

LECTURER OR ASSISTANT LECTURER : Telecommunications and Mathematics.

ASSISTANT LECTURERS : (1) Motor Vehicle Engineering ; (2) Carpentry and Joinery, Building Construction, &c.; (3) Plumbing, Domestic and Sanitary Engineering ; (4) Electrician's Work.

The Polytechnic is being erected on a 10-acre site on the water front within one mile of the centre of the city. Teaching blocks should be ready by mid-1958. Persons appointed to the first two posts mentioned required early 1958, others by the middle of the year.

All candidates should have suitable industrial or commercial and/or teaching experience in technical colleges.

Appointments of overseas persons will be on contract, Senior Lecturers for 6 years, with option of renewal for further three years ; others posts, in the first instance, on contract for three years. Accommodation with heavy furniture provided at rental of M$120/– per month. Members of staff pay 5 per cent. and the Board 15 per cent. of the salary for an Endowment Insurance Policy, former policies under schemes such as F.S.S.U. being taken over when possible. The Board is prepared to undertake negotiations with a view to safeguarding or carrying forward, if possible, benefits under other existing schemes. Satisfactory medical report necessary. Free medical attention provided and half cost of maintenance in hospital. Passages paid for overseas staff, wives and up to three children under 18 on first appointment, leave and completion of service. Two months leave per year's service, maximum tour for senior staff 2 years.

Salary scales (including allowances) :
Senior Lecturers, M$1800–M$50–M$1950 per month.
Lecturers, M$1600–M$50–M$1750 per month.
Assistant Lecturers Grade B, M$1200–M$50–M$1550 per month.
Assistant Lecturers, Grade A, M$1000–M$50–M$1350 per month.
(The Malayan Dollar is equal to 2s. 4d. Sterling.)
Entry point according to qualifications and experience.

Application forms available from the Council for Overseas Colleges of Arts, Science and Technology, 1, Woburn Square, London, W.C.1, should be returned not later than 31st August, 1957. E7737

WALSALL AND STAFFORDSHIRE TECHNICAL COLLEGE JOINT EDUCATION COMMITTEE

MECHANICAL ENGINEERING DEPARTMENT

Principal : H. CHEETHAM, B.Sc., Hons. A.M.I.Mech.E., M.I.Prod.E.

APPOINTMENTS

Applications are invited from suitably qualified persons for the following full-time teaching appointments, the duties in each case to commence on 1st September, 1957, or as soon as possible thereafter.

LECTURER IN MECHANICAL ENGINEERING

Applicants should be Graduates, have had adequate industrial and teaching experience, and be able to teach Mechanical Engineering subjects to the standard of the Higher National Certificate.

Salary according to the Burnham Technical Scale for Lecturers, viz.: £1200 by £30 to £1350 per annum.

GRADE A ASSISTANT IN MECHANICAL ENGINEERING

Applicants should be qualified to teach Mechanical Engineering subjects in Ordinary National Certificate Courses. Ability to teach Strength of Materials in Higher National Certificate Courses would be an additional qualification.

Salary according to Burnham Technical Scale, viz.: £475 by £25 to £900 per annum, with additions for training and experience.

Application forms and further particulars may be obtained from the Principal, Walsall and Staffordshire Technical College, Wisemore, Wallsall, Staffs., to whom completed application forms should be returned not later than Monday, 12th August, 1957.

V. MILLSON,
E7777 Secretary to the Joint Committee.

THE UNIVERSITY OF LIVERPOOL

DEPARTMENT OF MECHANICAL ENGINEERING

ASSISTANT LECTURER OR LECTURER

Applications are invited for the post of ASSISTANT LECTURER or LECTURER in the Department of Mechanical Engineering. The salary range for an Assistant Lecturer is £700–£850 per annum, the initial salary for a Lecturer will be within the range £900–£1500 per annum, according to qualifications and experience. Some knowledge of naval architecture is desirable, but not essential.

Applications, stating age, academic qualifications and experience, together with the names of three referees, should be received not later than 10th August, 1957, by the Registrar, from whom further particulars of the conditions of appointment may be obtained. E7618

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***Urgent advertisements may be telephoned to* CENtral 4565.**

PUBLIC APPOINTMENTS

VOCATIONAL EDUCATION COMMITTEE FOR THE CITY OF DUBLIN

CHIEF INSTRUCTOR IN WORK STUDY SCHOOL

The City of Dublin Vocational Education Committee invite applications for the temporary wholetime post as CHIEF INSTRUCTOR in its proposed Work Study School.

Applicants should have reasonably wide supervision experience in industry and :

(a) University Degree in Engineering or Associate Membership of a recognised Professional Institution of Engineers,

or

(b) Associate Membership of a recognised body of Cost Accountants, together with approved practical experience of Work Study.

Age Limits : 28 to 35 years.

Salary Scales : Single man—£1000 per annum. Married man—£1200 per annum.

The appointment will be for not less than three years. The successful applicant will be required to undergo initial training with Messrs. Urwick, Orr and Partners, and Maintenance Allowances during that period will be 5 gns. for a single man and 8 gns. for a married man. The person selected will be on full salary from date of commencement of training.

Application forms and conditions of employment are obtainable from the Chief Executive Officer, City of Dublin Vocational Education Committee, Town Hall, Ballsbridge, Dublin. The latest date for receipt of completed application forms is the 27th August, 1957. E7781

UNIVERSITY OF THE WITWATERSRAND

JOHANNESBURG, SOUTH AFRICA

PROFESSOR OF MECHANICAL ENGINEERING

Applications are invited for appointment to the post of PROFESSOR of MECHANICAL ENGINEERING, who is Head of the Department of Mechanical Engineering. Duties are to be assumed on 1st January, 1958, or as soon as possible thereafter.

The substantive salary attached to the appointment is on the scale £1950 by £50 to £2250 per annum. A married man will also receive a temporary cost-of-living allowance which is at present at the rate of £234 per annum. In addition, the substantive salary will be augmented by subvention from outside sources in the form of a non-pensionable allowance, which will guarantee an inclusive substantive salary at the rate of £2500 per annum until the end of 1963.

Membership of the Provident Fund is compulsory. Membership of the Staff Medical Aid Fund is compulsory in the case of an officer who is found eligible for such membership.

Applicants are advised to obtain a copy of the information sheet relating to the above vacant post from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close in South Africa and London on 31st August, 1957. E7594

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

BRUNEL COLLEGE OF TECHNOLOGY

WOODLANDS AVENUE, ACTON, W.3.

HEAD OF DEPARTMENT

This College is to open in new buildings in September, 1957, and will take over the advanced work of Acton Technical College.

Applications are invited for the HEADSHIP of the following department, which will be a Grade III department.

ELECTRICAL ENGINEERING.

Candidates should be highly qualified and have suitable industrial and/or research experience, and preferably some full-time and/or part-time university or technical lecturing experience.

There is an opportunity to build up new departments and to develop sandwich courses for the Diploma in technology, post-graduate technological courses and research.

Salary in accordance with the Burnham (Technical) Report, 1956, i.e., £1600 by £50 to £1750 plus London Allowance.

Further particulars and application forms (stamped addressed fooscap envelope) from the Clerk to the Governing Body, Middlesex County Council, Education Department, 10, Great George Street, Westminster, S.W.1, to whom completed forms should be returned by 16th August, 1957.

C. E. GURR, M.Sc., Ph.D.,
E7789 Secretary to the Education Committee.

THE UNIVERSITY OF MANCHESTER

LECTURER IN ENGINEERING (MECHANICAL)

Applications are invited for the post of LECTURER in ENGINEERING (MECHANICAL), with which Nuclear Engineering is combined. Preference will be given to candidates with major interests in heat transfer thermodynamics, mechanisms or machine design. University regulations permit teaching staff to read for the Degrees of M.Sc. and Ph.D. Applications will also be considered from engineers who would be interested in a temporary appointment of two or more years. The salary scale is as follows :—£900 to £1650 per annum. Membership of F.S.S.U. and Children's Allowance Scheme. Initial salary according to qualifications and experience.—Applications should be sent not later than August 17th, 1957, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained. Applications by air mail (no forms) will be considered from overseas candidates. E7662

PUBLIC APPOINTMENTS

FEDERATION OF MALAYA

MALAYAN RAILWAY ADMINISTRATION

RESIDENT ENGINEERS

Civil Engineers are required by the Malayan Railway Administration as RESIDENT ENGINEERS for employment on construction and/or design of new port works and also on general railway engineering work.

Appointment on contract/gratuity terms for 3 years in first instance.

SENIOR RESIDENT ENGINEER

Candidates must be Chartered Civil Engineers and have had not less than 10 years' experience in heavy engineering, preferably on port construction.

Gross emoluments :

Single men	£2268 per annum.
Married men without children	£2618 per annum.
Married men with children	£2849 per annum.

RESIDENT ENGINEERS

Candidates must be Chartered Civil Engineers or possess a University Degree or diploma recognised by the Institution of Civil Engineers, as granting exemption from Final Parts I and II of the A.M.I.C.E. examination plus 2 years' practical experience.

Gross emoluments, according to age, qualifications and experience, in scale :

Single men	£1218–£2120 per annum.
Married men without children	£1440–£2499 per annum.
Married men with children	£1531–£2730 per annum.

For candidates with experience in excess of the minimum quoted above, higher commencing salaries can be offered, e.g. a candidate with a Degree and 12 years' post-graduate experience would be eligible for gross emoluments as follows :

Single men	£1687 per annum
Married men without children	£2050 per annum
Married men with children	£2253 per annum.

On satisfactory completion of contract a gratuity at the rate of £232 or £324 per annum, according to salary, would be payable.

Free passages. Free medical attention. Generous home leave. Low Income Tax.

Apply : Director of Recruitment, Colonial Office, London, S.W.1. Give details of age, qualifications and experience. Quote BCD 110/23/04–05/D.4. E7780

MINISTRY OF TRANSPORT AND CIVIL AVIATION

CIVIL ENGINEERS

The Civil Service Commissioners invite applications for pensionable posts in London and certain large towns in the provinces.

Age : at least 25 and under 35 on 1st January, 1957, with extension for regular Forces service and appropriate civil service. Candidates must have achieved Corporate Membership of the Institution of Civil Engineers or have passed or been exempted from Sections A and B (now Sections I and II). They must have had experience in road and bridge construction and a knowledge of Highways Authorities' procedure is desirable.

London salary scale (men) £765 (at age 25) to £1190 (somewhat lower in provinces). Starting salary according to age up to £1030 at 34 or over. Prospects of promotion to higher grades on salary scales £1215–£1640 and £1690–£1950. Women's salaries lower, but being raised to reach equality with men's by 1961.

Further particulars and application forms from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. S.64–65/57.

Interview boards held at intervals, as required. Early application advised. E7727

SOUTH WESTERN REGIONAL HOSPITAL BOARD

APPOINTMENT OF SENIOR ASSISTANT ENGINEER (MECHANICAL)

Applications are invited for the post of SENIOR ASSISTANT ENGINEER (MECHANICAL), £1010–£1195. The post will be on the staff of the Regional Engineer at the headquarters in Bristol. Applicants must have passed the examination of the Institution of Heating and Ventilating Engineers or Sections A and B of the Institution of Mechanical Engineers or such other examinations qualifying exemption. Candidates should be capable of designing the mechanical engineering services for various types of hospital buildings, including the preparation of estimates, drawings and specifications. The post will be subject to the provisions of the Superannuation Regulations, 1956.

Applications, stating age, qualifications and experience, together with names of three referees, to be sent to the undersigned to be received not later than Tuesday, 3rd September, 1957.

M. O. CARTER,
Secretary.

27, Tyndalls Park Road,
Bristol, 8. E7767

NATIONAL COAL BOARD

EAST MIDLANDS DIVISION CARBONISATION DEPARTMENT

ENGINEERING DRAUGHTSMAN

Applications are invited for the post of ENGINEERING DRAUGHTSMAN at the Carbonisation Department Headquarters, Chesterfield. Salary range £655 to £765 per annum. Superannuation scheme. Five-day week.

Applications, giving details of experience and training, should reach the Administrative Officer, P.O. Box 16, Chesterfield, quoting C.S.V.83, not later than Saturday, 17th August, 1957. E7744

PUBLIC APPOINTMENTS

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

RISLEY, WARRINGTON, LANCASHIRE

SENIOR DESIGN ENGINEER

A vacancy exists with the Operations Branch of the Industrial Group of the United Kingdom Atomic Energy Authority, at its Headquarters at Risley, Warrington, Lancashire.

DUTIES

To be responsible to the Assistant Chief Engineer (Process Plants) for engineering design sections dealing with alterations and additions to diffusion plants and reactors ; for the investigation and preparation of schemes for improved plant efficiency, economy and safety, at existing works, and for the subsequent control of the cost of such schemes.

QUALIFICATIONS AND EXPERIENCE

Applicants must have served a recognised engineering apprenticeship and be Corporate Members of a Senior Engineering Institution, or have equivalent qualifications. Extensive experience of controlling a design team is essential. Knowledge of Diffusion and Reactor Plants will be an advantage but training will be arranged as necessary.

SALARY

Will be assessed within the scale £1705–£1980 p.a. A contributory pension scheme is in operation.

An Authority house for renting by the successful candidate, if married, may be available or, alternatively, substantial assistance may be given towards legal expenses incurred in private purchase.

Send a postcard for an application form, quoting reference 1989, to the Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, Warrington, Lancashire.

Closing date : 19th August, 1957. E7715

NATIONAL COAL BOARD

CENTRAL ENGINEERING ESTABLISHMENT

ENGINEER

ENGINEER required at N.C.B.'s Central Engineering Establishment, Stanhope Bretby, Nr. Burton-on-Trent, for work on the development of improved types of mining machinery and initially concerned with hydraulic transport of coal or with coal preparation machinery. Experimental developments will be carried out at the Establishment or at collieries. H.N.C. (Mech. Eng.) or equivalent qualification, with a recognised apprenticeship is desirable.

Appointment (superannuable), according to qualifications and experience, within present ranges £746 to £1310 or £466 to £935, with a minimum of £608 at age 25. These rates are under review.

Write, stating age, education, qualifications and experience, to Staff Dept., National Coal Board, Hobart House, London, S.W.1, marking envelope X714/2D, before 14th August, 1957. E7765

BRITISH RAILWAYS RESEARCH DEPARTMENT

VEHICLE AND TRACK DIVISION

SCIENTIFIC OFFICER GRADE I

A vacancy exists in the Vehicle and Track Division of the British Railways Research Department at Derby for a SCIENTIFIC OFFICER, Grade I.

Sound mechanical engineering training and academic or professional qualifications.

To take charge of a small group of Assistants engaged in measurement of movements and forces associated with vehicle and track interaction, usually from the aspect of the track.

Salary range : £1015 to £1120 per annum.

Superannuation fund and travel facilities.

Medical examination.

Applications, stating age, experience, &c., to : Director of Research, British Transport Commission, (British Railways Division), 222, Marylebone Road, London, N.W.1. E7718

CENTRAL ELECTRICITY AUTHORITY

EASTERN DIVISION

SENIOR DRAUGHTSMEN (MECHANICAL)

Applications are invited for the following appointments : SENIOR DRAUGHTSMEN (Mechanical), Generation (Construction) Department at Divisional Headquarters.

Salary N.J.B., Schedule "D," Grades 4/5, £800–£1045 per annum.

The commencing salary will depend upon experience and qualifications, but will be within the above range.

Applicants must have had experience in mechanical plant layout, pipework design.

Applications, stating age, qualifications, experience and present position, should be addressed to the Controller, Central Electricity Authority, Eastern Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts.

W. N. C. CLINCH,
E928 Controller.

LONDON COUNTY COUNCIL

ASSISTANT RESIDENT ENGINEERS

Required, ASSISTANT RESIDENT ENGINEERS for civil engineering contracts (1) at Northern Outfall Works, Beckton, E.6 ; must be able to set out works and have previous site experience. (2) in N.W. London area, experienced in sewer construction in tunnel, concrete and cast iron segments. Salaries up to (1) £1057 and (2) £846.—Application form from Chief Engineer (57/50), London County Council, County Hall, S.E.1. (1443.) E7757

PUBLIC APPOINTMENTS

REPUBLIC OF THE SUDAN

THE MINISTRY OF WORKS

APPOINTMENTS

The Ministry of Works require the following :

(a) SENIOR ELECTRICAL ENGINEER

Candidates should be Corporate Members of the Institution of Electrical Engineers, should have had experience in the design and development and working of alternating current distribution systems, network calculations and application of production gear, construction and operation of 11kV Power Stations. Experience of diesel engines installation and D.C./A.C. changeover will be an advantage. Age 35–45 (Reference 4/1818).

(b) CONSULTING ENGINEER (ROADS)

Candidates should be Corporate Members of the Institution of Electrical Engineers (or equivalent), have had at least 10 years' General Public Works experience, particularly on Road Survey and Construction, and with experience of work with Governmental or Local Authorities. A knowledge of Soil Mechanics or Air Photographic interpretation is essential and experience in the design and construction of low cost stabilisation methods would be an advantage. Experience in the preparation of documents and in the supervision of contracts and preparation of interim and final certificates. Age 35–45 (Reference 4/1829).

(c) ASSISTANT ROAD ENGINEER

Candidates should hold a recognised diploma in Civil Engineering or exemption from Parts 1 and 2 of the Associate Members of the Institution of Civil Engineers examination. Should have had at least 10 years' experience in modern road construction, particularly in respect of lightly constructed pavements. Age 35–45 (Reference 4/1806).

(d) MECHANICAL ENGINEER (ROAD PLANT)

Candidates should be Corporate Members of the Institution of Mechanical Engineers or hold equivalent qualifications, have a sound experience in the management of modern road equipment. The selected candidate will be responsible for the maintenance, repairs and general management of road plant throughout Sudan. Age 23–40 (Reference 4/1824).

Appointments will in all cases be on short term contracts for periods of 3 years. Salaries in the following scales will be assessed in accordance with age, qualifications and experience.

(a) £S.1866 to £S.2106.
(b) £S.2180 to £S.2360.
(c) and (d) £S.1146 to £S.1786.

A cost-of-living allowance is payable, together with an outfit allowance of £S.50. There is no income tax in the Sudan. Home leave on full pay with air passage accrues at the rate of 7 days per month.

Write, preferably on a postcard, for application forms and further information, to Sudan Embassy, Personnel Section, Cleveland Row, St. James's, London, S.W.1, quoting reference numbers. Closing date, 31st August, 1957. E7778

COMMONWEALTH OF AUSTRALIA

DESIGN ESTABLISHMENT, MELBOURNE

DEPARTMENT OF SUPPLY

APPOINTMENTS

Applications are invited for the following positions:

One SUPERVISING ENGINEER position, salary £A2158/£A2323, for testing of electrical and mechanical equipment.

Five SENIOR ENGINEER positions, salary £A1828/£A1993 :

1. Armament—Guns and Mortar.
2. Telecommunications.
3. Army Mechanisation.
4. Army Mechanisation.
5. Mechanical Testing—Vehicles and General Engineering Equipment.

For all positions candidates should have educational qualifications equivalent to A.M.I.Mech.E. or A.M.I.E.E. as appropriate.

Substantial experience in appropriate fields of work is required.

Location : Maribyrnong—suburb of Melbourne, Victoria.

When permanent appointment is accepted, the appointee is required to contribute to the superannuation fund.

First-class boat fare for the appointee and dependants (wife and dependent children) will be paid under specified conditions by the Commonwealth.

Application forms, together with a descriptive leaflet, obtainable from Senior Representative (A.P.82), Department of Supply, Australia House, Strand, London, W.C.2, with whom applications should be lodged by 6th September, 1957. E7739

MINISTRY OF SUPPLY

FIGHTING VEHICLES INSPECTORATE

CHEMIST (METALLURGIST)

Ministry of Supply requires CHEMIST (METALLURGIST) at Fighting Vehicles Inspectorate, Farnborough, Hants, to assist in direction of inspection of materials or be responsible for operating metallurgical and physical test laboratory. Successful candidate will be required to work at Kidbrooke, London, S.E.18, for first year. Qualifications : Hons. Degree in Chemistry, Metallurgy or Physics, or Associateship of Royal Institute of Chemistry, Institute of Metallurgists or Institute of Physics. At least three years' experience in factory or works laboratory. Sound knowledge of metallurgy essential and applicants must be capable of directing metallurgical investigations and compiling lucid technical reports. An acquaintance with radiography and application of X-ray diffraction methods desirable. Salary : £722 (age 25) to £1130 per annum.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting F.405/7A. E7776

Classified Advts. continued on page 4

PUBLIC APPOINTMENTS

ATOMIC ENERGY RESEARCH ESTABLISHMENT

HARWELL

SENIOR ENGINEER

Applications are invited from qualified Mechanical and Electrical Engineers for a post as ENGINEER-IN-CHARGE of the Engineering Services of buildings handling highly active materials. It is necessary in such buildings to provide all-purpose engineering support to the Scientific Staff and the Engineer will be responsible for the installation, operation and maintenance of special purpose and orthodox plant, including Chemical Pilot Plant, and for design and manufacture of equipment on a laboratory workshop scale. The management of a large staff is involved. Applicants should be Corporate Members of a Senior Engineering Institution and should, preferably, have a Degree in Engineering. Previous experience in a responsible managerial position is essential.

The post should be attractive to Works Engineers wishing to gain experience in the Atomic Energy field. The work is very diverse and offers good scope for initiative and drive.

Salary : £1235–£1655 (Engineer II).

Housing, superannuation and other excellent conditions.

Send postcard by 10th August, 1957, for further details and an application form, to Group Recruitment Officer (871Y/25), A.E.R.E., Harwell, Didcot, Berks. E7710

BRITISH OVERSEAS AIRWAYS CORPORATION

LONDON AIRPORT

CIVIL ENGINEERING ASSISTANTS

British Overseas Airways Corporation invite applications for the posts of CIVIL ENGINEERING ASSISTANTS at London Airport. Duties include assisting the Civil Engineer in the preparation of plans, estimates and specifications for engineering works and the supervision of their execution at home and overseas. The work is varied and interesting, connected, as it is, with the construction of new types of buildings at London Airport and other major centres overseas. Applicants should be Students or Associate Members of the Institution of Civil Engineers or other similar recognised professional institutions. Ages 23 to 45, preferably experienced in building and industrial engineering. Experience of reinforced concrete design an advantage and speedy draughtsmanship essential. Prepared to go abroad for short periods (with appropriate allowances). The commencing salary will be in the range of £910–£1085 per annum, in accordance with qualifications and experience. Excellent pension, staff insurance and leave facilities.—Write, giving full details in the first instance, to Assistant Staff Manager (Appointments), Recruitment Centre, B.O.A.C., London Airport. E7720

NORTH THAMES GAS BOARD

CHEMICAL PRODUCTS WORKS, BECKTON, E.6

A SENIOR DRAUGHTSMAN

A SENIOR DRAUGHTSMAN, aged 30–45, is required at the Chemical Products Works, Beckton, E.6.

Candidates should have considerable experience in the design and layout of plant from flow diagrams and in the preparation of schemes and contract specifications both for development and maintenance work.

Starting salary will be within the range £790 to £940 per annum, according to age, qualifications and experience. The successful candidate will be required to join the staff pension scheme.

Applications, giving age and full particulars, to Staff Controller, North Thames Gas Board, 30, Kensington Church Street, W.8, quoting reference 666/324. E7750

ADEN PORT TRUST

ASSISTANT PORT ENGINEER

The Board of Trustees invite applications for the post of ASSISTANT PORT ENGINEER. Applicants should preferably be Corporate Members of the Institution of Civil Engineers. Previous experience of harbour work is desirable. Free unfurnished quarters. Free superannuation scheme. Choice of short-term contract or permanent establishment.

Salary scale £1450 by £50 to £1950 ; the entry point would depend on the applicant's qualifications and experience.

Application forms and further details may be obtained from the Personnel Dept., Consulting Engineers and Agents, Aden Port Trust, 1, Lygon Place, Grosvenor Gardens, London, S.W.1 (Telephone : SLOane 0431). E7730

NATIONAL COAL BOARD

NORTH EASTERN DIVISION

ASSISTANT TO AREA CIVIL ENGINEER

Civil Engineer required as ASSISTANT TO AREA CIVIL ENGINEER at the No. 7 (Wakefield) Area. Salary range £875–£1325.

Applicants should have the Higher National Certificate as minimum qualification. They should have had a sound training in building and civil engineering work.

Knowledge of the design and construction of colliery works would be an advantage.

Apply to No. 7 Area Staff Manager, Newton Hill, Wakefield, by 9th August, 1957. E7746

PORT OF BRISTOL AUTHORITY

ENGINEERING ASSISTANT

Applications invited for above post. Duties mainly concerned with new works. Candidates should be capable of preparing schemes with minimum of supervision from initial survey through calculations and preparation of drawings to final contract documents.

Candidates should preferably be Corporate Members of Institution of Civil Engineers or have other suitable professional qualifications. Experience in dock engineering desirable but not essential.

Salary : £902, rising by £41 per annum, to £1107, but commencing salary within this range will depend upon age and experience. Appointment subject to medical examination and six months' probationary period. Post pensionable in accordance with provisions of Local Government Superannuation Act, 1953.

Applicants must disclose whether they are related to a member or senior officer of Bristol Corporation. Canvassing disqualifies.

Applications, stating age, qualifications, experience, &c., and enclosing copies of recent testimonials, in envelopes endorsed "Application—Engineering Assistant," to Engineer-in-Chief, Avonmouth Docks, Bristol, by 30th August, 1957. E7796

CENTRAL ELECTRICITY AUTHORITY

RESEARCH LABORATORIES, LEATHERHEAD, SURREY

SENIOR DESIGN ENGINEER

Candidates should have an Engineering Degree, Associate Membership of appropriate Professional Institution or equivalent qualification, and should have held senior positions in research or industry with responsibility for organising prototype design and construction. The successful candidate will be responsible for supervision, co-ordination and development of the existing drawing-office and workshop, and the development of these facilities for the design and construction of test rigs and prototypes for research projects, including nuclear power problems.

Salary within the scale £1385 to £1735 per annum.

Applications, stating age, experience, qualifications and present position and salary, should be forwarded to D. Moffat, Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, by 13th August. Quote Ref. ENR/342. E7786

NATIONAL COAL BOARD

CENTRAL ENGINEERING ESTABLISHMENT

MECHANICAL ENGINEER

MECHANICAL ENGINEER required at N.C.B.'s Central Engineering Establishment, Stanhope Bretby, Nr. Burton-on-Trent, as Head of Mechanical Development Engineering Section to be responsible to the Chief Development Engineer for planning and supervision of development of engineering projects. Good technical and practical training and academic qualifications are required.

Appointment (superannuable) according to qualifications and experience, within a present range £1400 to £1900 (under review).

Write, stating age, education, qualifications and experience, to Staff Dept., National Coal Board, Hobart House, London, S.W.1, marking envelope X/847 F, before 14th August, 1957. E7748

ADEN PORT TRUST

MAINTENANCE SUPERINTENDENT

The Board of Trustees invite applications for the post of MAINTENANCE SUPERINTENDENT, not more than 40 years of age, who will be in charge of the workshops, tugs and other floating plant. He should be a well-qualified mechanical engineer having served an engineering apprenticeship and being in possession of a First Class (Steam) Ministry of Transport Marine Engineering Certificate, or have a Steam Endorsement to a First Class Diesel Certificate, or hold a University Degree in Mechanical Engineering.

Salary of the appointment is £1900 by £60 to £2440 per annum under agreement. Free unfurnished quarters and medical attention. Gratuity or pension fund.

For full details apply on a post card to Personnel Dept., Consulting Engineers and Agents, Aden Port Trust, 1, Lygon Place, Grosvenor Gardens, London, S.W.1, or telephone SLOane 0431. E7729

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

PLANT ENGINEERING DIVISION

MECHANICAL ENGINEER

MECHANICAL ENGINEER required by the Plant Engineering Division of the Association in London, to lead a small team working on projects concerned with the application of modern techniques to iron and steel works, forging plants, &c. Candidates should have an Honours Degree in Mechanical Engineering. Some intimacy with the fundamental principles of the mechanical sciencies and their application an advantage. Starting salary in the range £900 to £1100 p.a., according to age, qualifications and experience. Post is superannuated under the F.S.S.U.—Written applications only, quoting "M.E. 12," to the Personnel Officer, B.I.S.R.A., 11, Park Lane, London, W.1. E7762

CENTRAL ELECTRICITY AUTHORITY

EASTERN DIVISION

CIVIL AND STRUCTURAL DESIGNER DRAUGHTSMEN

Applications are invited for the following posts at Divisional Headquarters, Cockfosters, adjacent to Cockfosters Station (Piccadilly Line) :—

CIVIL AND STRUCTURAL DESIGNER DRAUGHTSMEN

Salary : N.J.B., Schedule "D," within the range of Grades 4/5, £800 by £20 to £945 per annum, including London Weighting.

The commencing salary will depend on experience and qualifications.

New offices recently completed in pleasant surroundings, excellent working conditions. Canteen available. Sports and social club. Sick pay and superannuation schemes. Generous holidays.

The candidates appointed will be required to undertake civil and structural design work, and applicants should have had experience in the design and detailing of reinforced concrete structures for heavy plant, culverts, &c., and structural steelwork as applied to industrial buildings.

Applications, stating age, qualifications and experience, should be sent to the Controller, Central Electricity Authority, Eastern Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts.

W. N. C. CLINCH,
Controller.
E974

LEYTONSTONE (No. 10) HOSPITAL GROUP

LANGTHORNE HOSPITAL

ASSISTANT ENGINEER

Applications are invited for the post of ASSISTANT ENGINEER at Langthorne Hospital, E.11.

Candidates must possess a sound knowledge of Boiler House Practice and Mechanical Engineering. Possession of the Ordinary National Certificate or equivalent qualification desirable. Salary scale : £585 per annum, rising by varying annual increments over a period of 5 years to £710 per annum. In addition London Weighting Allowance is payable.

Application forms from the Group Secretary, Langthorne Hospital, E.11, to be returned within 7 days from appearance of this advertisement. E7810

BRITISH RAILWAYS

ASSISTANT RESIDENT ENGINEERS

ASSISTANT RESIDENT ENGINEERS required at Manchester and Derby for supervision of bridge repair work and bridge construction contracts. Sound technical knowledge and experience in this class of work essential.

Salary range £916–£956 per annum.

Residential and other favourable travelling concessions.

Superannuation scheme.

Apply to :
Chief Civil Engineer (Ref. 46),
British Railways, London Midland Region,
5a, Euston Grove, London, N.W.1.
E7773

FIFE COUNTY COUNCIL

COUNTY ENGINEER'S DEPARTMENT

DRAUGHTSMAN/SURVEYOR

DRAUGHTSMAN/SURVEYOR required for County Engineer's Department. Salary A. and P. scale III, £635 to £680 per annum. House may be available. Superannuation scheme. The duties comprise surveying, preparation of drawings for water and drainage projects and applicants should have considerable experience in surveying and levelling. Further details and forms of application from the County Engineer, Belfield, Cupar.—Applications to be lodged by 10th August, with the County Clerk, County Buildings, Cupar. E7758

MEDICAL RESEARCH COUNCIL

HAMMERSMITH HOSPITAL

DESIGNER DRAUGHTSMAN

A DESIGNER DRAUGHTSMAN, to take charge of small drawing-office. Interesting work on remote controls for medical isotope production. H.N.C. and mechanisms experience desirable. Treasury scales. Good conditions.

Senior Cyclotron Engineer, Medical Research Council, Hammersmith Hospital, Ducane Road, W.12. E1123

ST. THOMAS' HOSPITAL LONDON S.E.1.

SENIOR ENGINEER

Experience in plant maintenance and supervision and maintenance of oil-fired W.T. boilers, ancillary plant, thermal storage, heating, domestic hot water, kitchen equipment and mechanical ventilation, &c. Naval or marine experience preferred. Salary £770 to £920, including London weighting.—Apply, stating age, qualifications and experience, to the Clerk of the Governors. E7787

NATIONAL COAL BOARD

N.W. DIVISION

NO. 1 (MANCHESTER) AREA

GROUP MECHANICAL ENGINEER

GROUP MECHANICAL ENGINEER required for No. 1 Group. Salary range, £925 to £1425 per annum.

Applicants must have had extensive practical experience in the installation, operation and maintenance of modern surface and underground equipment. They should have held responsible engineering posts, and the possession of a Higher National Certificate, or equivalent qualification, would be an advantage.

Applications, stating age, qualifications, experience and present salary, to the Area Staff Manager, No. 1 (Manchester) Area, Walkden, Nr. Manchester, within 14 days. E7723

ATOMIC ENERGY RESEARCH ESTABLISHMENT

HARWELL

TECHNICAL ILLUSTRATOR

TECHNICAL ILLUSTRATOR required at the Atomic Energy Research Establishment, Harwell, to produce high-quality cut-away and exploded perspective drawings in line, tone or colour, to prepare illustrative diagrams.

£505 (at age 21) to £795.

Housing, superannuation and other excellent conditions.

Send postcard by August 9th, 1957, for further details and an application form, to :

Group Recruitment Officer (869/Y/25), A.E.R.E., Harwell, Didcot, Berks. E7711

LANCASHIRE COUNTY COUNCIL

HEATING AND VENTILATING ENGINEERS

Required, HEATING AND VENTILATING ENGINEERS. Salary range £727–£1107. Applicants should have had a wide experience in the design of all types of heating and ventilating, cold water and gas installations for all types of buildings, and should have an industrial background. Corporate Membership of the Institution of Heating and Ventilating Engineers is desirable and advantageous.

Application forms to be obtained from and returned to the County Architect, P.O. Box 26, County Hall, Preston, as early as possible, quoting ref. A/TE. E7638

TENDERS

BOARD OF MANAGEMENT FOR THE PORT OF RANGOON

DEVELOPMENT OF RANGOON PORT

CIVIL ENGINEERING CONTRACT NO. 2

Comprising

TRANSIT SHEDS, WAREHOUSES AND WORKSHOPS

The Board of Management for the Port of Rangoon invite Civil Engineering Contractors to TENDER for Contract No. 2 for the DEVELOPMENT of the PORT of RANGOON.

The work involved in this contract includes the complete provision and erection in structural steel with concrete floors and brickwork of three Transit Sheds, part double storeyed, each approximately 450ft. long by 200ft. wide ; one double-storeyed Warehouse, approximately 293ft. long by 100ft. wide ; one single-storey Crane Maintenance Shop, 320ft. long by 130ft. wide ; and one single-storey Warehouse, 210ft. long by 150ft. wide.

These buildings are to be erected on and behind Sule Pagoda Wharves Nos. 5, 6 and 7, now under construction by separate contract. Tenders will be considered only from contractors of established reputation in building and civil engineering, and the structural steelwork is required to be supplied by approved specialist firms in structural steelwork. The structural steelwork section may be undertaken either by the main contractor or by a nominated sub-contractor within the main contract. Brief particulars of experience and the financial standing of the contractors should accompany the application.

The contractor whose Tender is accepted may be required to furnish a security as specified in the Tender documents.

The closing date for Tenders, which are to be addressed to the Chairman to the Board of Management for the Port of Rangoon, P.O. Box No. 1, Rangoon, will be 12 noon on Saturday, 28th September, 1957. Tenders will be invited on the basis of a priced bill of quantities.

Applications for formal Tender documents from bona-fide firms of contractors who intend to tender for the work should be made to the office of the Chairman in Rangoon or to the Board's Consulting Engineers, Sir Alexander Gibb and Partners, Queen Anne's Lodge, Westminster, London, S.W.1, as soon as convenient. The Tender documents will be despatched to tenderers early in August. A deposit of £100 sterling or K.1300 per set will be required from each contractor who makes application for the Tender documents. Additional sets may be obtained on payment of further deposits as above. Deposits will be refunded only following the submission of a bona-fide Tender by the contractor and the return of the Tender drawings and documents in good condition.

U WIN PE,
Chairman.
E7721

TENDERS

GOVERNMENT OF IRAQ

DEVELOPMENT BOARD AND MINISTRY OF DEVELOPMENT, TECHNICAL SECTION II

DAURA BRIDGE, BAGHDAD

1. A new highway bridge is to be designed and constructed over the River Tigris in Baghdad, approximately 300 metres south of the Iraq Cement Works.
2. The bridge shall carry a 14 metre roadway and two 3 metre footways, and shall have a total length between abutments of 384 metres or thereabouts.
3. It is the ultimate intention of the Ministry of Development to invite a limited number of suitable firms of international repute to submit their proposals for the complete design and construction of the bridge.
4. In the first instance, however, firms or joint venture groups interested in being considered for final selection and invitation to participate are requested to submit full details of their organisation, capacity and qualifications for design, capacity for construction, experience of works of a similar nature and for whom executed, and all other relevant particulars, so as to arrive by registered mail in the offices of Technical Section II, Ministry of Development, Baghdad, Iraq, not later than twelve noon on Monday, 12th August, 1957. Envelopes should be endorsed "Daura Bridge."
5. A limited number of firms will be selected by the Ministry from those submitting particulars under para. (4) above, and such selected firms will be invited to prepare and submit designs and priced tenders for construction based upon full survey and site investigation details, conditions of contract, and specifications, prepared by the Ministry's Consulting Engineers, Messrs. Coode and Partners, London, England.
6. A period of approximately three months will be allowed for the preparation and submission of designs and tenders, which will then be checked by the Consulting Engineers and presented to the Development Board with a recommendation for acceptance of one tender.
7. All firms participating in the final submission, and whose designs and quotations are checked and found to be proper, reasonable and practicable, shall each receive the sum of ID. 750 from the Ministry of Development in recognition of their services.
8. Any further information regarding the project may be obtained from Technical Section II, Ministry of Development, Baghdad, or from Messrs. Coode and Partners, 9, Victoria Street, London, S.W.1, England.

MINISTER OF DEVELOPMENT.
E7630

CITY OF GEORGE TOWN—PENANG

AYER ITAM RESERVOIR

CONTRACT NO. PW.2

TENDERS are invited by the City Council of George Town, Penang, Malaya, for the CONSTRUCTION of an EARTH DAM on the Sungei Ayer Itam on Penang Island. The dam will be of rolled earth fill about 140 feet high, with a crest length of about 700 feet, containing approximately 750,000 cubic yards of material. Ancillary works include Diversion and Overflow Tunnels and an Outlet House.

The contract documents, drawings and instructions as to Tendering may be inspected on or after the fourteenth day of August, 1957, either at the office of :

(a) The City Engineer, George Town, Penang.
(b) Messrs. Binnie, Deacon and Gourley, Artillery House, Artillery Row, London, S.W.1.

Firms desiring to Tender may obtain copies of the contract documents, drawings, &c., between the fourteenth day of August, 1957, and the sixth day of September, 1957 (both days inclusive), either from the City Engineer, Penang, on payment of a cheque for 43 Malayan dollars made payable to the Treasurer, City of George Town, Penang, or from Messrs. Binnie, Deacon and Gourley, upon payment of a cheque for £5, made payable to Messrs. Allen and Williams, 1, Victoria Street, London, S.W.1, who are Agents to the City of George Town, Penang.

Particular attention is drawn to paragraph No. 9 of the Instructions to Persons Tendering, namely, that Tenders will only be accepted from firms of contractors who have previously executed works of a similar nature and magnitude.

Tenders must be submitted either to the City Council, George Town, Penang, Malaya, by 4 p.m. on Monday, twenty-eighth October, 1957, or to Messrs. Allen and Williams, 1, Victoria Street, London, S.W.1, by 10 a.m. on Monday, Twenty-eighth October, 1957.

BINNIE, DEACON & GOURLEY,
Consulting Engineers.

Artillery House,
Artillery Row,
Westminster,
London, S.W.1. E7709

INDIA STORE DEPARTMENT

LOCO. BOILER

The Director-General of India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

	Quantity, Nos.
LOCO. BOILER, "DS" Class, for B.G. Locomotives	3

Forms of Tender may be obtained from the above address on or after the 2nd August, 1957, at a fee of 10s., which is not returnable. If payment is made by cheque, it should please be made payable to "High Commissioner for India." Tenders are to be delivered by 2 p.m. on Thursday, 12th September, 1957.

Please quote reference No. 451/57 RLY. E7790

TENDERS

WARWICKSHIRE COUNTY COUNCIL

TO HEATING AND ELECTRICAL ENGINEERS

Firms desirous of having their names placed upon a list of approved contractors from whom the Warwickshire County Council will invite Tenders for Schemes costing £1250 and over for :

1. Heating, hot and cold water supplies, gas and steam services, and/or
2. Electric light and power installations,

should make application on or before Monday, 2nd September, 1957, to G. R. Barnsley, F.R.I.B.A., County Architect, Shire Hall, Warwick.

Applicants must forward particulars of contracts recently executed by them, giving the names and addresses of local authorities or persons to whom reference can be made. Tenders will be considered only from firms included in the official list which will be compiled by the appropriate committee after consideration of applications.

Contractors whose names are already included on the Council's approved list need not make application.

L. EDGAR STEPHENS,
Clerk of the Council.

Shire Hall,
Warwick,
July, 1957. E7740

HINDUSTAN STEEL (PRIVATE) LTD.

COAL WASHING PLANT

Hindustan Steel (Private), Ltd., c/o Ministry of Steel, Mines and Fuel (Department of Iron and Steel), invites sealed TENDERS, Ref. No. 11 (3)-7/56, for the SUPPLY and ERECTION of a COAL WASHING PLANT, including all necessary auxiliary units, at Dugda, on the Jharia Coalfields in Bihar. Detailed specifications, drawings, &c., and particulars of the scope of the Tender and conditions of contract may be obtained on all working days from Room No. 321, Multi-Storeyed Building, King Edward Road, New Delhi, on payment of Rs. 500 (Rupees five hundred only) per set by bank draft only, made out in the name of Hindustan Steel (Private), Limited. This amount of Rs. 500 is not refundable.

Tenders should reach this office by 4 p.m. on 20th September, 1957, and should be accompanied by earnest money of Rs. 1 lakh (rupees one lakh). The Tenders will be opened at 11 a.m. on 21st September, 1957, in the presence of such of the tenderers as may be present.

The Hindustan Steel (Private), Limited, reserves the right to reject any or all Tenders or to accept any Tender considered advantageous to the Company, whether it is the lowest or not, without assigning any reason whatsoever. E7768

EDUCATIONAL

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guaranteed Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E721 E

FREE! Brochure giving details of Courses in Mechanical and Production Engineering, Draughtmanship, &c., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other Professional examinations. —E.M.I. Institutes, Dept. E30, London, W.4. (Associated with H.M.V.) E972 E

WORK STUDY.—Part-time (evening) 20 weeks' Diploma Course starts September 9th. Enrolments open now.—Details of this and five other courses, including full-time (six weeks) and correspondence, from School of Time and Motion Study, 29, Cork Street, W.1. Regent 0516. E7617 E

UNIVERSITY OF MANCHESTER

The next Session commences on Thursday, 3rd October, 1957. E7704 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED

A LEADING COMPANY engaged in the production of all types of radio and electronic equipment requires the services of an INDUSTRIAL DESIGNER. This is an unusual opportunity for an imaginative man to work on new projects, styling wood and metal cabinets. The ability to exploit new materials is essential. This is a position of responsibility and a qualified man F.S.I.A. or M.S.I.A.) is preferred. The salary paid will be commensurate with the responsibilities involved. East London area. Please reply, giving full details, to BOX No. E7771, "The Engineer." A

A VACANCY EXISTS in well-known engineering works in Nottingham for a man able to undertake time study and rate fixing, one-off shop engaged in machine tool reconditioning. Five-day week. State experience and salary required.—Widdowson's, Canal Street, Nottingham. E7754 A

A VACANCY EXISTS with Smiths Motor Accessories Ltd., for a First-class DESIGNER with wide experience in the light and precision engineering field. The successful applicant may be a Graduate Mechanical Engineer with progressive outlook and at least seven years' design experience in a senior capacity, preceded by practical experience or apprenticeship. He will be required to produce complete prototype designs to a specification, and contribute clear thought and new ideas.—Apply to : Mr. D. H. Squire, Cricklewood Works, N.W.2. GLA. 3333. E7806 A

SITUATIONS VACANT

A LARGE WEST MIDLAND ENGINEERING FIRM, with a world-wide reputation for quality and situated within 15 miles of Birmingham, have the following vacancies and invite applications from suitably qualified men.

SENIOR PRODUCTION ENGINEER

Applicants should possess an Engineering Degree or be a Member of a recognised Engineering Institution, and have had considerable experience in the automobile field with particular experience on engines and transmissions. Applicants must possess drive, initiative and a flair for originality in production methods and be also capable of controlling production.

METHODS ENGINEER

Applicants should possess an Engineering Degree or be a Member of a recognised Engineering Institution and have had considerable experience in the latest machine shop practices, and be an authority on the manufacture of gears for quantity production. Experience on production of automobile transmissions will be an advantage.

QUALITY ENGINEER

This appointment calls for a man with considerable machine shop and metrology experience and having a minimum qualification of Higher National Certificate in Production Engineering. Applicants must be fully experienced in all branches of inspection procedure, practical and administrative, including statistical methods of quality control. Should be conversant with A.I.D. procedure and be, or have been, A.I.D. approved.

All the above positions are of a high standard and carry attractive terms of employment, with great opportunities in the future. Remuneration will be commensurate with experience and qualifications. Apply, in strictest confidence, giving full details of age, education, present and previous positions held and salary required, addressed to Managing Director, BOX No. E7735, "The Engineer." A

AN ENGINEER, with a thorough working knowledge of electronics applied to servomechanisms, is required for research and basic development work in gyroscopic and allied fields. A sound grasp both of theoretical and practical problems in design is required.—Applications to the Chief Research Engineer, S. G. Brown, Limited, Shakespeare Street, Watford, Herts. E7669 A

AIR-CONDITIONING ENGINEER required to develop up this department of a Midland firm.—BOX No. E1111, "The Engineer." A

APPLICATIONS ARE INVITED from DEVELOPMENT ENGINEERS to fill a vacancy as a member of a small team engaged on the development of manufacturing techniques. The appointment is in the Manchester area and is concerned with the products of a group of companies with factories in this country and overseas. Applicants should preferably be qualified as A.M.I.Mech.E., but consideration will be given to Graduate Members if they are suitable in other respects. In either case candidates should have extensive experience in plant and machine design. All possible facilities in the way of plant, equipment, &c., are provided in our own specialised workshops and the work demands enthusiasm, creative ability and original thinking about the projects concerned. A commencing salary of up to £900 is offered, together with membership of a non-contributory pension scheme and the opportunity for promotion within our group of companies. —BOX No. E7747, "The Engineer." A

APPLICATIONS ARE INVITED from PROJECT ENGINEERS over 28 and having H.N.C. minimum qualification, for vacancies in the Development Engineering Department at Ferodo Limited. This is a senior staff appointment and candidates must have had experience in one or more of the following subjects :—

Special plant design, heating, ventilating and dust collection, production engineering and plant layouts, factory mechanical services layouts.

They will be responsible for handling the projects through initial investigation, preparation of estimates and reports, ordering plant and equipment and arranging for installation.

Write, giving details of age, previous experience and salary required, to the Personnel Manager, Ferodo Limited, Chapel-en-le-Frith, Via Stockport. E7791 A

ASSISTANT TECHNICAL OFFICERS (DRAUGHTSMEN) are required by IMPERIAL CHEMICAL INDUSTRIES, LTD., Dyestuffs Division, at Manchester and Huddersfield, for design work in connection with new projects for the manufacture of synthetic fibres, synthetic resins and other chemicals. Applications are invited from Mechanical Engineering Draughtsmen with good technical qualifications (Higher National Certificate minimum) and preferably with general engineering design experience.—Applications should be made in the first instance to Staff Department, Hexagon House, Blackley, Manchester, 9. E7613 A

ATOMIC ENERGY.—Applications are invited by firm based in London and New York for a situation to cover the marketing in United Kingdom and Europe of essential equipment of British and American origin. Applicants should be around 30, have a University Degree in Engineering (or similar), a leaning towards organisation, and preferably some commercial or sales experience. After suitable training he should be able to work largely on his own and develop a new division. A commencing salary of around £750/£1250 is proposed, plus incentive scheme, expenses, pension, motor-car. Operating from London applicant would have the benefit of office and sales staff in principal U.K. cities and agents set up in Europe. Please submit full personal details.—BOX No. E7760, "The Engineer." A

A. BOAKE, ROBERTS AND CO., LTD., Carpenters Road, London, E.15, require a CHIEF ENGINEER, who must be a man of the highest qualifications and very wide experience. The preferred age is 55–60 years, but an older man with the necessary qualities could be appointed. Gentlemen who have already applied for this post are asked not to apply again. Applications should be addressed to the Works Director. E7763 A

BRITISH WEST INDIES.—British company having substantial machine shop and ship repair business, requires JUNIOR ENGINEER, age 25/30. Salary £1000/£1200 p.a.—Write, giving particulars of experience and qualifications, to BOX "Y.F.," c/o J. W. Vickers and Co., Ltd., 7/8, Great Winchester Street, London, E.C.2. E7811 A

SITUATIONS VACANT

BOOTS PURE DRUG CO., LTD., ENGINEERING DEPARTMENT

Boots Pure Drug Co., Ltd., invite applications from GRADUATE MECHANICAL ENGINEERS for a progressive position that will result from the development of Work Study throughout the Engineering Department.

This department, which employs over 600 people, comprises nine separate sections, each under its own Works or Section Engineer, responsible to the Chief Engineer for the installation, maintenance and repair of mechanical and electrical equipment in our Pharmaceutical, Chemical, Printing and other works and warehouses ; for the development and construction of much special-purpose plant and for the design, specification and operation of all engineering services, including the generation and distribution of steam and electricity from our two power stations.

Applicants, who should be not more than 35 years of age, should have had a thorough works training, preferably followed by some years' experience in the pharmaceutical, chemical or food manufacturing industry. Experience in Work Study would be a further advantage, but training would if necessary be given in this, as well as in other aspects of the department's work. —Application, giving full details of education, training and career to date, should be sent to the Personnel Manager, Station Street, Nottingham. E7736 A

CHIEF DRAUGHTSMAN

Large Modern Producers of Man-Made Fibres require CHIEF DRAUGHTSMAN, to take charge of staff up to 25 working on capital projects and maintenance. Experience in the chemical/textile industry an advantage. Min. quals. A.M.I.Mech.E. or A.M.I. Chem.E. Applications invited from suitable men in age range 30/50. Good salary and prospects. Pension scheme, assistance with housing.—Applications, in confidence, stating age, qualifications, experience and previous positions in chronological order, addressed to Personnel Manager, British Enka Ltd., Aintree, Liverpool, 9. E7706 A

CIVIL ENGINEER.—A senior vacancy exists within a leading engineering organisation for a man possessing a Degree in Civil Engineering. Must be fully experienced in civil work on large-scale industrial contracts. Salary up to £2000 p.a., according to age and experience. Please write full details, in strict confidence.—BOX No. E7764, "The Engineer." A

CIVIL ENGINEER

Shell Refining Company, Limited, require a CIVIL ENGINEER for their Shell Haven Refinery in Essex. Applicants should possess a University Degree and/or A.M.I.C.E., and be not over 31 years of age.

The work will comprise site supervision of civil contracts : foundation, road rail and drainage design ; the drafting of specifications ; taking out bills of quantities. A practical knowledge of surveying is required and some experience with a major civil contractor is essential.

Salary according to age, qualifications and experience. Contributory pension scheme. Educational endowment scheme. Facilities available for assistance in house purchase.—Applications to Shell Refining Company, Limited, P.O. Box 83, Shell Court, White Kennett Street, London, E.1. E7595 A

COMMERCIAL DIRECTOR.—Leading British company with extensive interests in U.K. and overseas, wish to appoint a Commercial Director. The company's interests lie mainly in the chemical field and the organisation specialises in contracting for large chemical plants. The appointment calls for a candidate with extensive technical and commercial experience in the negotiation of large contracts, preparation of specifications, estimates, cost control, buying, invoicing and legal procedure. The successful candidate would have a seat on the Board. Applicants should submit full details of experience and salaries earned, which will be regarded as strictly private and confidential.—BOX No. E1121, "The Engineer." A

CONSULTING ENGINEERS require competent Structural Steelwork Designer for various types of buildings. Five-day week, holiday commitments honoured.—Apply, stating details of experience and salary required, Alan Marshall and Partners, 73–74, High Holborn, W.C.2. E1112 A

CONTRACTORS' AGENT for London civil engineers, to control and administer road and drainage schemes, large scale, mainly London and South of England. Willing to work isolated areas ; subsistence allowance paid. Must be experienced in setting out, measuring and preparation of final accounts. Able to drive modern company's car. Age up to 45 years. Non-contributory pension scheme. Starting salary £1250 p.a., with excellent prospects of advancement.—Apply in first instance by writing to Laurel and Co., Employment Specialists, 19, Basinghall Street, London, E.C.2. E7761 A

DEPUTY CHIEF ENGINEER is required by a leading petroleum chemical firm. Preferably aged 35/45. Applicant must be fully qualified and have experience in large-scale continuous process plant. Some administrative experience is essential. Salary will be dependent on age and experience.—BOX No. E7728, "The Engineer." A

DESIGNER-DRAUGHTSMAN, with experience water-tube boilers, required for newly forming company, south of London. Good prospects and salary. —BOX No. E1080, "The Engineer." A

Classified Advts. continued on page 6

SITUATIONS VACANT

DESIGN AND DEVELOPMENT ENGINEER

A progressive company situated near the West Midlands industrial area finds that its plans for the future have created a new vacancy. The successful candidate will be from 25–35 years of age, preferably with an Engineering Degree, and will be concerned with the design and development of intake and exhaust silencers, and possibly other products, in connection with which diesel engine experience would be of advantage. Requests for application form, with brief details of experience.—BOX No. E1110, "The Engineer." A

DESIGN/CONTRACTS ENGINEER required by well-known company. Must have experience in water screens, rotary screens and allied equipment. Excellent staff service conditions; superannuation scheme.—Apply in writing, stating age, experience, qualifications and salary required, to Personnel Manager, BOX 3B E137, A.K. Advg., 212a, Shaftesbury Ave., London, W.C.2. E7807 A

DESIGNER-DRAUGHTSMEN & DETAILERS wanted for work on chemical plant layout, vessel design and pipework, &c. Top salaries offered men with experience and maximum assistance in regard to housing. Grant towards removal expenses and living allowance until removal completed. Pension and insurance scheme, technical library, sports ground.—Apply, "ref. D," Staff Personnel Manager, Power Gas Corpn., Ltd., Stockton-on-Tees. E7738 A

DESIGNERS, DRAUGHTSMEN AND CHECKERS

A leading firm of Consultant-Contractors to the Oil and Chemical Industries is prepared to engage men in the following categories :—

Piping Designers	Salary range : £1200 to £1500 p.a.
Piping Draughtsmen	Salary range : £1100 to £1300 p.a.
Piping Checkers	Salary range : £1200 to £1400 p.a.
Structural Designers	Salary range : £1200 to £1500 p.a.
Structural Draughtsmen	Salary range : £1100 to £1300 p.a.

The positions are permanent and pensionable, and there are opportunities for promotion. Experienced men only are required. If you have experience in any of the above categories, write, giving details of previous career.—BOX No. E7779, "The Engineer." A

DEVELOPMENT ENGINEER required for a position of senior engineering responsibility in an integrated iron and steelworks where considerable development is to take place.

The successful candidate will be responsible for all new development and the co-ordination of planning and site work.

Applicants, who should be between 30 and 50 years of age, must be Corporate Members of the appropriate Institution of Civil, Electrical or Mechanical Engineers, and should be educated to Degree standard.

Engineering experience in steelworks or heavy plant manufacture is essential.

Application forms are available from :
The Labour Officer,
Richard Thomas & Baldwins, Limited,
P.O. Box No. 7,
Redbourn Works,
Scunthorpe, E7658 A

DRAUGHTSMAN required, with experience in either mechanical design, plant layout or pipework detail. Salary : £700 to £800 per annum, according to age and experience. Good prospects. Superannuation scheme. Applications are invited from Draughtsmen, aged 24/35, and educated up to O.N.C. or equivalent standard. Write, giving details of education, experience and age.—BOX No. E1124, "The Engineer." A

DRAUGHTSMEN required in the following categories : Senior and Junior Piping and Instrumentation ; Senior and Junior Reinforced Concrete ; Senior Mechanical, by engineers in City engaged on nuclear, petroleum, chemical plants. H.N.C./O.N.C. desirable. Salaries above average, five-day week, pension/life assurance and personal accident schemes, house purchase assistance, luncheon vouchers.—Write full particulars to Head Wrightson Processes, Ltd., 24/26, Baltic Street, E.C.1. E954 A

DRAUGHTSMEN required with general engineering experience in automobile or rolling stock to train as Design Engineers on specialised suspension systems. Excellent prospects. Pension scheme in operation. Situation approximately 20 miles south of London.—Apply in writing, stating age, training, general experience and salary expected, to BOX Y.703, c/o Streets, 110, Old Broad Street, E.C.2. E7752 A

DRAUGHTSMEN required immediately for handling Structural Steelwork Contracts. Pension and bonus scheme. Luncheon vouchers. Five-day week.—Write, stating age, experience and salary required, to Joseph Parks and Son, Ltd., 22, Buckingham Gate, S.W.1. E7798 A

DRAUGHTSMEN who have a sound knowledge of mechanical engineering, design or detailing, and can produce a high-class drawing, are required for interesting positions at the Weston-super-Mare establishment of a large engineering organisation. Salaries will be above new union rates and a pension is available. Conditions are excellent.—Apply, giving experience, age and qualifications, quoting "Director," to BOX No. E7529, "The Engineer." A

ENGINEERS with specialised training in the design and execution of prestressed concrete projects are required for permanent employment in Rhodesia and the Union of South Africa. Free passages, pension scheme, excellent prospects.—Full details to BOX JY/29, c/o 95, Bishopsgate, London, E.C.2. B973 A

ENGINEER, ASSISTANT CHIEF, large metal smelting and refining works, London area. Must be fully experienced and capable of organising and handling men. Salary £1200 p.a.—BOX No. E1116, "The Engineer." A

ENGINEER/DRAUGHTSMAN.—An interesting position in Contractor's Plant Department on Research and Development in connection with mechanical equipment. Men with experience of mechanical or civil engineering, or both, are invited to write in the first instance, to Personnel Manager, Holland and Hannen and Cubitts, Ltd., 1, Queen Anne's Gate, London, S.W.1. E7785 A

ENGINEER required to visit engineering works in Great Britain to meet executives and give talks and demonstrations to production personnel. Considerable experience of production methods is required. Car provided and travelling expenses paid. Superannuation scheme in operation. Details of age, experience and qualifications, should be sent to BOX No. E7755, "The Engineer." A

EXPERIENCED CHIEF DRAUGHTSMAN required, for small mechanical and chemical engineering drawing-office of growing Anglo-American company in Camberley. Previous experience in drawing-office organisation essential, with sound grounding in mechanical engineering. Dynamic and enthusiastic approach to problems essential. Permanent and pensionable appointment.—Apply to GPB. Sharples Centrifuges, Limited, Tower Works, Doman Road, Camberley, Surrey. E7772 A

FORD MOTOR COMPANY, LIMITED, have vacancies for DRAUGHTSMEN capable of preparing schemes for both high and low-pressure water heating systems, air-conditioning and boiler-house layout and ancillary equipment.

Successful applicants will be responsible for drawing up specifications and schedules of quantities, for scrutinising tenders and progressing contracts. They should be able to work with the minimum of supervision. H.N.C. or Membership of I.H.V.E. is desirable, but not essential.

Salary according to experience and ability, with participation in a generous non-contributory pension scheme.

Please write to Salaried Personnel Department, Ford Motor Company, Limited, Dagenham, Essex, giving details of age, experience and qualifications, and quoting reference DPS. E7766 A

GRADUATE MECHANICAL ENGINEER

A Graduate Engineer is required by a progressive British company as Technical Assistant to a Senior Graduate Engineer at one of its modern processing factories. Many problems of a technical nature arise, and the successful applicant will take responsibility for handling these. The responsibility is clearly defined and initial training over many months will be given to prepare the new man for the position.

A good Degree in Mechanical Engineering and some basic workshop training is necessary. The company is prepared to delay the appointment should the right applicant not be immediately available. Age limit 28 years. This position is a starting point in the organisation and an excellent commencing salary will be paid to which will be added substantial increments in line with his progress and development.

In judging applicants the company will be looking at the man's development possibilities, both technical and administrative, as the company has a long record of healthy growth and wants its new men to be capable of growing with it. All factors such as superannuation scheme, &c., are available to suitable candidates, who should send, in confidence, a brief outline of their career to date.—BOX No. E7734, "The Engineer." A

HEAT TRANSFER AND FLUID FLOW.—RESEARCH AND DEVELOPMENT ENGINEER required by an old-established engineering company in the Glasgow area. Applicants, aged 25-30, should have a University Honours Degree in Engineering and some research experience. The work would involve the theoretical design and practical testing of new types of heat exchanger. A good salary would be paid to an applicant with the necessary qualifications. Apply, giving age and full particulars.—BOX No. E788, "The Engineer." A

HUMPHREYS & GLASGOW, LTD., have a vacancy for a WELDING SUPERVISOR and RADIOGRAPHER fully conversant with Class I work on pressure vessels and pipelines.—Apply in writing, stating experience, salary, &c., to G. E. Mitcham, Humphreys and Glasgow, Ltd., Humglas House, Carlisle Place, London, S.W.1. E7792 A

INSPECTOR (SENIOR) required by large chemical and industrial engineering company. Applicants must have had previous experience of inspecting the construction and manufacture of pressure vessels, chemical plant, fractionating columns, structural steelwork, &c. Should also be conversant with Lloyd's and A.S.M.E. Codes of Practice. Salary up to £1100 p.a.—Please write, in confidence, to BOX No. E7753, "The Engineer." A

INSTRUMENT ENGINEER.—Instrument men who have completed a trade apprenticeship, have subsequently had a minimum of five years' experience with a major user and/or manufacturer of process control instruments and who are technically qualified to Higher National Certificate standard in electrical or mechanical engineering, are invited to apply for the post of Assistant Instrument Engineer at the Newport factory of Monsanto Chemicals, Limited. A scheme of training for instrument mechanics has been set up at the factory and the successful candidate in addition to his other duties, will take an active part in its operation. Non-contributory pension scheme. —Applications in writing, stating age, experience and qualifications, to be addressed to the Personnel Manager, Monsanto Chemicals, Limited, Corporation Road, Newport, Mon. E7756 A

MECHANICAL ENGINEER required by Smiths Motor Accessories Ltd., H.N.C. standard and at least 5 years' practical experience in light engineering, preferably instrument testing.—Apply to : Mr. D. H. Squire, Cricklewood Works, N.W.2. GLA. 3333. E7805 A

JOHN LAING AND SON LTD.

are expanding their Mechanical and Electrical Design Department, which is engaged in a wide variety of work, including the design and development of Building and Civil Engineering Plant and Equipment ; the introduction of further mechanisation into construction processes, including materials handling equipment ; techniques for the production of a range of building components and the specification and design of machinery for their factory production.

Applications are invited for the following vacancies at the Research and Development Centre, Boreham Wood, Herts :—

SENIOR DESIGN ENGINEER (One required), to be responsible, under the Department Head, for the work of a group of Designers and Draughtsmen. Preferably A.M.I.Mech.E. with wide design experience in similar or allied fields. Age approximately 30–50.

DESIGN ENGINEERS (Two required), of Degree or H.N.C. standard or equivalent, and capable of undertaking design work.

ASSISTANT DESIGN ENGINEERS (Four required).

DESIGN DRAUGHTSMEN (Five required).

These posts are progressive and pensionable. The work is varied and interesting and holds attractive prospects in an expanding field. 5-day week, canteen and sports club facilities. Those interested should write for an application form to :—

Personnel Manager (S.D.B.7),
JOHN LAING AND SON LIMITED,
Page Street, London, N.W.7.
E7686 A

LARGE PUBLIC COMPANY requires, for new large subsidiary factory, first-class WORKS TECHNICIAN for the manufacture of universal motors suitable for portable tools and similar appliances. Must combine best works and technical design experience, able to evolve new motor types and be up-to-date with the latest modern mass production and factory management methods. Suitable candidate offered highly attractive contract, together with housing assistance and other long-term benefits. Present staff advised. Write fully, in confidence, to Technical Director, BOX No. E1115, "The Engineer." A

MECHANICAL ENGINEER

Markham and Co., Ltd., have a vacancy for a suitably qualified Mechanical Engineer as an Assistant to the Experimental Engineer at their works in Chesterfield. Applicants should have a knowledge of vibration analysis as applied to the Heavy Engineering Industry. Previous experience in experimental work on projects of original design is essential.

Applicants should give age, concise details of education and past experience, duties and degree of responsibilities.—Applications should be addressed to the Secretary, Broad Oaks Works, Chesterfield. E7795 A

METALLURGISTS

The Metropolitan-Vickers Electrical Company require GRADUATE METALLURGISTS with or without previous experience, for the following vacancies in their Research Department.

Long-term investigational work on the development and application of new materials and methods of manufacture. This work is principally in the ferrous field, and applicants should possess a good knowledge of physical metallurgy.

Short-term investigational work in connection with day-to-day manufacturing problems and the control of incoming materials. This work involves close co-operation with the Engineering Departments, and applicants should have some bias towards engineering.

Excellent equipment and facilities are available in newly built laboratories, and considerable opportunities exist for men with initiative and ability. These posts are pensionable. Applicants should be free from National Service commitments.

Write, giving full particulars, including age, sex, nationality, education and experience, and quoting "M.9," to :
Personnel Manager,
Metropolitan-Vickers Electrical Co., Ltd.,
Trafford Park,
Manchester, 17. E7775 A

PLANT ENGINEER FOR COKE OVENS

required on an integrated iron and steel works, where large extensions of Coke Producing Plant are to be built.

Applicants should be educated to at least H.N.C. standard and must have served a recognised apprenticeship in mechanical engineering.

Candidates should be preferably between 30–50 years of age.

Application forms are available from :
The Labour Officer,
Richard Thomas and Baldwins, Limited,
Redbourn Works,
Scunthorpe, Lincs. E7657 A

MECHANICAL DRAUGHTSMEN (SENIOR AND JUNIOR).—Bell Punch Company, Ltd., of Uxbridge, have vacancies for Senior and Junior Draughtsmen accustomed to the preparation of production drawings from prototype design. Education to H.N.C. or O.N.C. standard preferable, and experience in light engineering industry desirable. Excellent salary range.—Apply in writing, giving details of age, experience and qualifications, to Personnel Department. E7678 A

PUBLICITY ASSISTANT

Bruce Peebles and Co., Ltd., Engineers, Edinburgh, require a man with experience in technical journalism and ability to write lucid descriptions of electrical engineering products and processes for publicity, press and other purposes. The successful applicant will be required to assist with the writing and editing of a works magazine and should preferably have a good electrical engineering qualification.—Replies, stating full details of education, training, experience, age, present post and salary, to J. S. Baillie, Publicity Manager, at the above address. E7685 A

RICHARDSONS WESTGARTH (HARTLEPOOL), LTD.,

have vacancies at Hartlepool for

DRAUGHTSMEN

for detail and arrangement work.

These are new posts created by expansion of our works programme and offer permanent employment and excellent prospects to the right men.

Applications are invited from men with experience of steam and gas turbines, condenser plants, feed heating systems and general power station equipment.

There are pension and life assurance schemes in operation. Good starting salaries will be paid commensurate with the qualifications and experience of the applicants.

Initial interviews can be arranged at mutually convenient places and times.

Applications, which will be treated in strict confidence, should be addressed to the Group Personnel Officer, Richardsons, Westgarth and Co., Limited, P.O. Box No. 2, Wallsend, Northumberland. E7684 A

SALES ENGINEER required for the London office of a leading firm of pump and compressor manufacturers. Applicants should have a sound knowledge of pumps and/or compressors and their application and should be used to estimating. Good salary and prospects for suitable applicant. Apply in confidence stating age and experience.—BOX No. E1089, "The Engineer."

SALES MANAGER (ELECTRICAL ENGINEER)

Instrument Division of well-known Group seeks Sales Manager. Applicants should preferably be Graduates and/or have served a full student apprenticeship in Electrical Engineering. They must have some familiarity with control systems and complicated circuitry, preferably based on experience in instruments, control gear or telecommunications. The post offers excellent prospects at the higher management level to a man with technical versatility and commercial acumen; location London. Contributory pension scheme, minimum salary £2000 per annum.—Applicants should send full particulars to Messrs. Linklaters and Paines (J.H.F.), 59/67, Gresham Street, London, E.C.2, marking envelopes "Electrical Engineer," and be prepared to attend an interview board. The strictest confidence will be extended and expected. E7751 A

SAO PAULO LIGHT S.A.—SERVICOS DE ELETRICIDADE, a company in Brazil and subsidiary of the Canadian Corporation, Brazilian Traction, Light and Power Company Limited, invite applications from suitably qualified men for the position of SHIFT CHARGE ENGINEER in the Piratininga Power Station. The power station was completed about three years ago and is situated near Sao Paulo (pop. 2·5 millions ; temperate climate 2200ft. above sea level). The plant comprises initially 2×80MW., 1800 r.p.m. steam turbo-alternator units, each supplied at 850 p.s.i., 900 deg. F. by one 850,000 lb/hr. oil-fired boiler, and is now being expanded by the addition of two 125,000kW reheat units, 1800 p.s.i., 1000 deg. F. Applicants should have a sound technical knowledge and wide experience of the operation of modern turbines and boilers, preferably with oil or pulverised-fuel firing, should also have an aptitude for supervision and the maintenance of harmonious labour relations. Good salary, three years' agreement, subject to renewal with first-class passage both ways ; four months paid leave after three years' service.—Written application, in the first instance, should be made to Mr. W. P. Kellett, Joint Manager, Canadian Brazilian Services, Ltd., 148, Leadenhall Street, London, E.C.3. E7636

SENIOR CHEMICAL DESIGN ENGINEER

A fully qualified CHEMICAL ENGINEER is required by large modern Producers of Man-Made Fibres with own Research and Development Depts. The successful applicant will be required to lead a design team and responsibilities will include commissioning of new plant, evaluation of performance and the preparation of flow charts and operating procedure. Applications are invited from men with first-class experience in the age range 30/50. Good salary and prospects. Pension scheme, assistance with housing.—Applications, in confidence, stating age, qualifications, experience and previous positions, in chronological order, addressed to Personnel Manager, British Enka Ltd., Aintree, Liverpool, 9. E7705 A

SENIOR DESIGNER-DRAUGHTSMAN, with flair for design work, required by small/medium-size engineering firm in South-West London building paper-making machinery. Previous experience in the field is not essential, but applicants should have qualifications at least equal to Higher National Certificate standard. The work is interesting with opportunities for studying equipment in the field. The prospects are good. Pension scheme.—BOX No. E7593, "The Engineer."

SITUATIONS VACANT

SENIOR DESIGN DRAUGHTSMAN

required for preparing tooling layouts and tool drawings for multiple-spindle automatics. Must be capable of working on own initiative and to be responsible for a new auto development design department.—Applications, with full particulars, to BOX No. E7745, " The Engineer." A

SENIOR DESIGNER-DRAUGHTSMAN required for road construction machinery. Experience in road roller design an advantage. Pension scheme —Apply, giving particulars of experience and salary required, to Chief Designer, Thomas Green and Son, Ltd., Smithfield Ironworks, Leeds, 2. E7574 A

SENIOR ELECTRICAL ENGINEER required for interesting and varied work. A.M.I.E.E. and/or Graduate, with experience in modern power distribution, rotating and static equipment, electronics, instrumentation, design of automatic controls, modern heating techniques, &c. Age 30 to 40 with knowledge and experience of modern labour control and administration. Salary commensurate with qualifications and experience.—Apply in writing to the Personnel Manager, Ferodo Limited, Chapel-en-le-Frith, Via Stockport. E7713 A

SMITHS MOTOR ACCESSORIES LTD.

require :—

SENIOR DESIGN DRAUGHTSMAN with experience of instruments or light engineering. Minimum qualifications, 3 years' design experience, O.N.C. standard. Monthly status for right man.

SENIOR DRAUGHTSMAN for Production Drawing Office, with experience of instruments or small mechanisms, at least O.N.C. standard. Knowledge of press work an advantage.

QUALITY CONTROL ASSISTANT ENGINEER.—O.N.C. (Mech.). Experience of instruments or small mechanisms. To ascertain causes of developed faults.

WORK STUDY ENGINEERS.—Fully qualified.

PLANT LAYOUT DRAUGHTSMAN.—O.N.C. or equivalent, with experience of minor building alterations. Layout of Machine Tools.

METHODS ENGINEER.—Sound mechanical background with some knowledge of assembly procedure and layout.

Apply to Mr. D. H. Squire, Cricklewood Works, N.W.2. GLA.3333. E7803 A

SENIOR DESIGNERS required for mechanical handling machinery as applied to brewery industry. Salary according to ability, but not less than £900 p.a., with prospects. Pension scheme, canteen, five-day week.—Apply to Chief Draughtsman, G. Hopkins and Sons, Ltd., United House, North Road, London, N.7. E7742 A

SENIOR DRAUGHTSMAN required for layout and detail of mining plant. Draughtsman with general engineering experience would be suitable. Good working conditions, five day week, pension scheme.—Apply stating age, experience and salary required to Personnel Manager (M.G.E.), The General Electric Company, Limited, Fraser and Chalmers Engineering Works, Erith, Kent. E7635 A

SENIOR STRUCTURAL ENGINEER required by firm of Consulting Engineers in South West London. M.I.C.E. or M.I.Struct.E. preferred. Minimum age 40. Must be experienced in commercial and industrial buildings in reinforced concrete and steel. This is a permanent, pensionable position and good prospects exist for right man. Salary according to age, experience and qualifications.—BOX No. E7797, " The Engineer." A

JOHN SUMMERS AND SONS LIMITED

require a SENIOR ENGINEER to take charge of Hot and Cold Rolling Mills at Shotton.

Applications to Company Secretary, Hawarden Bridge Steelworks, Shotton, Chester. E1125 A

TECHNICAL REPRESENTATIVE, to sell portable power tools. Knowledge of industrial firms and users in Surrey, Kent, Sussex and Hants an advantage. —Apply in writing, Sales Manager, Armstrong Whitworth and Co. (Pneumatic Tools), Ltd., 40, Broadway, London, S.W.1. E7726 A

THE GENERAL ELECTRIC COMPANY, LIMITED,
have vacancies for
OPERATING ENGINEERS
for the Operational Service Department of the Turbine Division at Erith, Kent.

The duties involve dealing with a wide range of operating problems on turbo-alternators from 400kW to 120,000kW capacity and on blowers up to 100,000 c.f.m.

Minimum qualifications are H.N.C. and a sound experience of power station operation.

Apply, giving age and details of experience, to Personnel Manager (O.E.), The General Electric Company, Limited, Fraser and Chalmers Engineering Works, Erith, Kent. E7649 A

TECHNICAL ASSISTANT for interesting experimental work embracing mechanical and electro-hydraulic systems. H.N.C. is desirable, plus good practical experience. Attractive salary to right man. Modern factory. Good working conditions. Canteen.—Apply in writing to J. Dewar, Personnel Officer, Lansing Bagnall Ltd., Kingsclere Road, Basingstoke, Hants. E7802 A

THE BRUSH ELECTRICAL ENGINEERING CO., LTD., has a number of interesting vacancies in both Technical and Commercial Departments of its General Engineering Division for the following staff :

SENIOR ELECTRICAL ENGINEER.

SENIOR MECHANICAL DRAUGHTSMAN.

ELECTRICAL SECTION LEADER DRAUGHTSMAN.

ELECTRICAL DRAUGHTSMAN.

TENDERING AND CONTRACT ENGINEER for Complete Steam Power Stations.

TENDERING ENGINEER for industrial electrification schemes.

The Division is responsible for the design and layout of complete steam power stations, factory electrification projects and the application of electrical energy in industry.

Whilst previous experience in these fields is not essential, it is desirable, and oversea experience would be an added qualification for the first post above. Applicants for this post should also be Chartered Engineers, and for posts two and three should hold a Higher National Certificate, whilst an Ordinary National Certificate is desirable for post four.

Applicants for the last two commercial appointments should preferably have commercial experience, although training can be given if necessary. Oversea experience would be an advantage, as would be an academic qualification.

Good salaries will be paid, and conditions of service include a generous non-contributory superannuation scheme.

Please apply to the Chief Personnel Officer, Brush Electrical Engineering Co., Ltd., Loughborough, Leics. E7804 A

THE NESTLE CO., LTD., require a MACHINE TOOL ENGINEER, to be responsible for tinshop quality control, tool and precision machine maintenance in their Northern Irish manufacturing centres. All applicants must have had practical experience and served an approved apprenticeship. Prior tinshop experience an advantage, but not essential, as a familiarisation period on this type of plant can be arranged. Age limit 30–35. The post carries staff status and salary would be according to experience. Excellent pension scheme and housing provided.—Applications to The Nestle Co., Ltd. Production Division, Hayes, Middlesex (ref. IHC). E7722 A

THE NESTLE CO., LTD., require a qualified and experienced MECHANICAL ENGINEER for their new factory to be erected near Carlisle, Cumberland. The successful candidate would also assist in the planning stages and supervise the erection of this factory. Prior experience on process plant, boiler plant and refrigeration essential. Age limit 33/38. Salary according to experience, excellent pension scheme and housing provided.—Applications to The Nestle Co., Ltd., Production Division, Hayes, Middlesex (ref. IHC). E7701 A

THE YORKSHIRE COPPER WORKS, LIMITED,
requires a DRAUGHTSMAN
for interesting and varied work in their Development Department.

The successful applicant must be an alert young man with Ordinary or Higher National Certificate in Mechanical Engineering, and who has served a recognised apprenticeship in engineering and had experience in drawing-office work.

This is an excellent opportunity for a permanent position with good salary and prospects for the right man. In addition, there is a pension scheme and a co-partnership scheme (assistance with housing will be considered where necessary).

Applications, giving full details of experience and present salary, marked " Development Draughtsman Confidential," to the Personnel Supervisor, Yorkshire Copper Works, Ltd., Leeds, 10. E7743 A

An opportunity occurs with

GRESHAM - LION GROUP

for a qualified ENGINEER capable of earning a high salary to reorganise and expand a mechanical design and drawing-office dealing mainly with transformers and switchgear. Ability to organise, train and up-grade staff essential. Excellent opportunities for rapid promotion within the group of companies.

Write : Technical Director, Gresham House, Hanworth, Middlesex. E7784 A

CANADA

MECHANICAL ENGINEER

Required as Chief Designer for Canadian firm manufacturing variety of heavy machinery.

Applicant must be an Engineering Graduate or have equivalent status, 35 to 40 years of age, capable of promoting design for both economy and practicability, as well as control of quality consistent with design intent and facilities of manufacture.

Salary commensurate with experience and qualifications.

Please reply in detail, stating experience, education, &c. All replies will be kept in strict confidence.

Reply to Dept. D.E., Canadian Department of Labour, 61, Green Street, London, W.1. E6913 A

BOOKS and PUBLICATIONS

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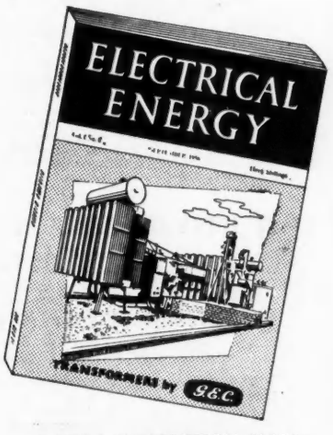

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Whetstone, Nr. Leicester
Require

Sales & Contracts Engineers

to undertake commercial work associated with the construction of

NUCLEAR POWER STATIONS

Applicants must have a H.N.C. in either Mechanical, Heavy Electrical or Structural Engineering, and a good practical background in one of these fields of Engineering. There are senior posts available for men with previous commercial experience, but inexperienced applicants may be considered for more junior positions.

Please write, giving age, full details of qualifications and experience, to Central Personnel Services, Marconi House, 336/7, Strand, London, W.C.2, quoting reference E1897F. E7741 A

Classified Advts. continued on page 8

SITUATIONS VACANT

DIESEL PROJECT DEVELOPMENT ENGINEERS

REQUIRED BY

ENGLISH ELECTRIC, RUGBY

These vacancies are essentially of a research nature and would be suitable to engineers holding an M.Sc. or higher degree in thermodynamics, structures or fluid dynamics.

Applications can also be considered from pure scientists, who are prepared to undertake original engineering investigations.

Write, giving full details, to Dept. C.P.S., Marconi House, 336/7, Strand, W.C.2., quoting ref. E1104A. E7707 A

SITUATIONS VACANT

FACTORY MANAGEMENT

A young and growing company, with Head Office in London and companies in Britain, the United States of America and Australia, wishes to recruit for its U.K. organisation an engineering or scientific graduate with sound and successful production experience in industry. Candidates should be 27 to 35 years of age, experienced in production management, shop-floor relations and work study, with first-rate qualities of personality and leadership and a modern outlook on new methods in production problems. Starting salary up to £1750 p.a. with progress to £4000 p.a. in a period which is unlikely to be longer than eight years. Pension and life assurance scheme and full range of benefits. The company is keen to recruit a young production executive of outstanding promise whose one ambition is to reach the top at an early age.—Details, please, to BOX No. E7712, "The Engineer." A

SITUATIONS VACANT

THE ROVER CO., LTD., SOLIHULL

EXPERIENCED SENIOR CAR DEVELOPMENT ENGINEERS

are required for interesting new car projects in an expanding engineering programme.

SALARY

Dependent on qualifications and experience, the salary grade is up to £1500 per annum.

PENSIONS

A Staff Contributory Pension Scheme is available after a short period of service.

LOCATION

The company's Head Office and Assembly Plant is situated on the southern outskirts of Birmingham and is adjacent to many attractive residential districts.

Applications, with full particulars, should be addressed to: Labour Manager, The Rover Co. Ltd., Lode Lane, Solihull, Warwicks. E7717 A

STEWARTS AND LLOYDS LIMITED

OF CORBY, NORTHAMPTONSHIRE

have a few vacancies for

SENIOR DRAUGHTSMEN & PLANT DESIGNERS

These vacancies occur in a New Development Department of this large integrated Iron, Steel and Steel Tube Works. Applicants should possess Higher National Certificates but those with Ordinary National Certificates will be considered if they have reasonable experience in design. Corby is a New Town and housing conditions are favourable; Staff Hostel accommodation is normally available for single men.

5 day week; good welfare, canteen and recreational facilities; superannuation and life assurance scheme.

Good salaries based on experience and qualifications.

Applications will be treated as confidential and should be made, giving details of age, qualifications, experience and salary required to:-

Manager/Personnel **STEWARTS AND LLOYDS LIMITED CORBY, NORTHANTS.** E83 A

A.E.I. — JOHN THOMPSON NUCLEAR ENERGY COMPANY LIMITED.

MECHANICAL ENGINEER

to work on the design and development of mechanisms associated with nuclear power stations.

The work provides scope for original thought on varied equipment essentially of a novel nature. Applicants will be required to handle schemes, varying from light to medium engineering, through design and development stages up to commissioning.

A Degree or equivalent standard is required, and some design experience on mechanism work, associated structures and electro-mechanical systems and drives is essential. Experience on control systems generally, electrical or hydraulic, etc., though not essential, would be considered an advantage.

The company's new design offices provide excellent working conditions and high-class dining and travel facilities are available. The company operates a contributory pension scheme.

Please reply in writing to the Chief Engineer, Radbroke Hall, Knutsford, quoting Reference MED/S. E7716 A

HAMWORTHY ENGINEERING LIMITED, POOLE.

This Company, situated on the Dorset Coast, invites applications for interesting and progressive positions as listed, at their various establishments in Poole. The products are Pumps (Centrifugal and Positive Displacement), Compressors, Oil Burning Equipment and Hydraulic Pumps and Control Valves. In the last five years, turnover has increased fourfold and due to a continued increase in the Company's sales, a further considerable expansion is being planned. Employees now number about 650 and may be expected to increase to about 1000 in three years.

The Company's policy is to promote from within, hence applications will be surveyed with the view to further ultimate promotion after proven ability.

The conditions of employment are amenable, with canteen and pension scheme facilities, &c.

Applicants please apply in writing at once to Personnel Officer, New Quay Road, Poole, quoting ref. and stating full details of age, training, qualifications, experience, marital status, availability and ultimate position aimed at. Absolute confidence is guaranteed.

Ref. 1 : **WORKS MANAGER**—Hydraulics Division.
Age 35–45. Must be fully qualified and experienced in Precision Production, including Methods, Jig and Tool Design, Production Control, &c. It is essential that drive, energy and tact are also possessed for this important and developing appointment, as well as the ability to plan further expansion.

Ref.2 : **PRODUCTION SUPERINTENDENT**—Hydraulics Division.
Age 35–40. Essentially a time-served apprenticeship and experienced in precision production ; to control machine and assembly shops. Only those now holding similar positions should apply.

Ref. 3 : **METHODS ENGINEER**—Hydraulics Division.
Age 30–40. This key appointment requires a highly qualified and skilled Production Engineer, whose interests may ultimately expand beyond hydraulics. As he will be responsible for tooling and methods, it is essential that an apprenticeship has been served with ultimate experience in Jig and Tool, Drawing-Office, Tool Room, Work Study and Methods.

Ref. 4 : **TEST ENGINEER.**
Must be qualified H.N.C., methodical and critical in his approach to high technical performance. Some electrical background desirable, but basically fluid dynamics for hydraulics engineering. The candidate sought is one of broad test experience who may later be involved in testing large pumps, compressors and oil-burning equipment.

Ref. 5 : **INSPECTORS.**
Practical men with machine shop experience and extensive previous Inspection duties ; vacancies exist in all departments of the Company.

Ref. 6 : **SUPERVISORS.**
Setters and Charge hands for machine shop and assembly. Only those with proven supervisory experience will be considered and these posts involve shift work. Age preferable 30–35.

Ref. 7 : **DESIGNERS.**
The Company seeks men of H.N.C. and/or Degree qualification, preferably with experience in Pumps and Compressors or suitable experience for the other products involved.

Ref. 8 : **DESIGN DRAUGHTSMEN AND DRAUGHTSMEN.**
Requirements in the various age groups for interesting work in pumps (centrifugal and positive displacement), compressors, oil burning and hydraulics. O.N.C. and/or H.N.C. desirable.

Ref. 9 : **JIG AND TOOL DRAUGHTSMEN.**
With adequate experience of either precision production or tooling for batch work (press tool experience unnecessary). Must be able to develop tool design from method layouts. Age 25–40. Preferably O.N.C.

Ref. 10 : **TECHNICAL SALES ESTIMATORS.**
Age 25–30. Although previous similar experience is desirable, it is not essential, but the requirement is for ex-Drawing-Office personnel with ability to develop in tendering and customer contact. The Company normally draws its Sales Engineers from this source.

Ref. 11 : **CONTRACTS ENGINEERS.**
Age 25–35. Essentially qualified and methodical administrators, preferably with site experience. Sound engineering training essential, but yet with commercial acumen.
E7719 A

IMMEDIATE VACANCIES FOR ADDITIONAL PREMISES

Following an ever increasing volume of work, we are able to provide opportunities for the following:

● PROCESS PIPING ENGINEERS

Preparation of flow diagrams for process and utility systems. Engineers in these positions will work intimately with the process design of refinery and chemical plants and handle problems of instrumentation, pumping, gas compression, heat exchange and other unit operations. A sound technical background with degree or H.N.C. will be required, but as it will be necessary for the successful candidates to acquire an understanding of the processes and plants involved, a period of initial training will be allowed for at full salary.

● INSTRUMENT ENGINEERS

Graduate engineers or with equivalent professional qualifications. Must have had wide, practical experience of oil refinery instrumentation.

● SENIOR MECHANICAL EQUIPMENT ENGINEERS

Selection and handling of equipment in all aspects of refinery and chemical plant engineering.

COMPREHENSIVE PERSONNEL BENEFITS

We offer unusually comprehensive personnel benefits, excellent working conditions and the opportunity to improve your engineering knowledge.
Frankly, we are appealing to the discerning type of person who is interested in a sound and promising future. Holiday commitments will be honoured. To save your time and ours, please telephone only if you possess the qualifications required.

KELLOGG INTERNATIONAL CORPORATION
7-10 CHANDOS STREET, LONDON, W.1.
TELEPHONE: MUSEUM 4010, *EXT.* 130

E7714 A

SITUATIONS VACANT

STRUCTURAL DESIGN ENGINEERS AND DESIGN DRAUGHTSMEN

A number of interesting vacancies are available with a drawing-office engaged upon the design of overhead structures in connection with Railway Electrification contracts.

Location is at Kirkby, near Liverpool. Pay, prospects and general conditions of employment are excellent, including superannuation scheme, bonus and five-day week.

Applications, giving details of age, qualifications and experience, should be submitted to:

Works Personnel Officer,
Reference C/2,
British Insulated Callender's Cables, Ltd.,
Prescot, Lancs. E7650 A

SITUATIONS VACANT

GENERAL SALES MANAGER

for a medium engineering company manufacturing a range of products used extensively in the power, refining, chemical and marine industries and by government departments and local authorities. The company, which is situated in the North East of England, is only 20 years old, employs about 750, has a turnover exceeding £1½ million and a reputation for original design and production.

The General Sales Manager will be responsible to the Board of Directors through the Managing Director for planning and implementing sales policy, finding and fostering new markets, directing the home and export sales managers and through them branches, distributors, outside representatives and an office staff of 60.

Candidates must have several years' senior management experience controlling a sales force selling engineering products—preferably associated with liquids (e.g. valves, pumps, &c.). An engineering degree or other professional qualification is also desirable. Preferred age about 40. Salary £3000 per annum with a generous pension scheme, a car and good promotion prospects. —BOX No. E1087, "The Engineer." A

SITUATIONS VACANT

THE CHAMBERLAIN GROUP OF COMPANIES

wish to appoint a

TECHNICAL DIRECTOR

to their mechanical engineering subsidiary as the result of reorganisation for expansion of the business.

The requirements for the post are a good basic education, training and apprenticeship in light mechanical and structural engineering. Preference will be given to applicants with experience in hudraulics, aged about 40, with A.M.I.Mech.E. or similar qualifications.

He will have complete control of design, development and production and works costing, together with overall responsibility for sales.

The post is permanent and pensionable and will carry surtax class salary. Applications from people not already receiving salaries in this class will not be considered.

Please send full particulars of education, apprenticeship and subsequent career, in strictest confidence, to The Managing Director, 3, Buckingham Palace Gardens, London, S.W.1. E1117 A

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Applications are invited from Mechanical Draughtsmen who are contemplating emigrating to Canada and who possess the following qualifications :—

Experience in steam generation or industrial process piping is essential. Able to prepare intricate high-pressure piping and major mechanical equipment drawings for construction purposes. Layout and detail drawings for water services, including fire protection, sewage disposal and surface drainage and also generating station substructure embedded piping.

Experience need not cover the full range indicated.

All positions are pensionable and carry an attractive health and insurance scheme. Special sick leave plan and vacations with full pay.

Salaries on Canadian scale and commensurate with experience and qualifications.

Write to Ontario Department of Immigration, 25, New Burlington Street, London, W.1, for application form. E966 A

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APPLY : BUSINESS MANAGER, BIRMINGHAM P.O. Box 45

E7634 A

SITUATIONS WANTED

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EXPERIENCED DESIGNER, A.M.I.Mech.E., seeks responsible position in light engineering. Well educated, would consider post as designer or technical author in Southern England. Present salary £775.—BOX No. E1113, "The Engineer." B

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CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E575 MW

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FOR HIRE

LATTICE STEEL Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1 'Phone, SLOane 5259). E112 K

PATENTS

THE PROPRIETORS of British Patent No. 708,552, for "IMPROVEMENTS IN AND RELATING TO THE SUPPLY OF AIR TO COMPRESSED AIR APPARATUS, MORE PARTICULARLY TO SUBTERRANEAN WORKS," desire to enter into negotiations with a firm or firms for the Sale of the Patent or for the grant of Licences thereunder.—Further particulars may be obtained from Marks and Clerk, 57 and 58, Lincoln's Inn Fields, London, W.C.2. E7749 H

THE PROPRIETOR of British Patent No. 709,777, entitled "POWER TRANSMISSION MECHANISM FOR FARM IMPLEMENT," offers same for Licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14E, Jackson Blvd., Chicago 4, Illinois, U.S.A. E7759 H

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PARK LANE.—Self-contained Office Suite on ground and lower ground floor, 2400 square feet. Long lease. £3000 p.a. inclusive of rates and heating. No premium. Early possession.—Goodwin and Co., 139, Park Lane, London, W.1. Mayfair 7081. E1109 L

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READY MONEY for Redundant Electrical Equipment. Complete works bought outright for expert and rapid dismantling.—F. C. Larkinson, Ltd. (Est. 1880), Hitchin Street, Biggleswade, Beds(Tel. 2391) ; 12 branches throughout the country. E959 F

WANTED, Machines of all Types.
CASH PAID.
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PUMPING PLANT

Certain items of PUMPING PLANT, electric and petrol, will be FOR DISPOSAL in a few months' time. Interested parties can in the meantime see the plant working. Particulars of such plant can be obtained from the Borough Engineer, Town Hall, Harwich, Essex. Tel., HAR 811.
Dated the 2nd August, 1957.
T. B. A. MOONLIGHT,
E7774 G Town Clerk.

600

SINGLE/3-PHASE CONVERSION EQUIPMENT

Quantity of WESTINGHOUSE Static 4kVA. Converters, input 200/250V., single phase ; or 400/440V. single phase ; output 415/3/50, complete with static condenser and all auxiliaries.
Pilot Motor Capacitor Converters available for loadings up to 50 h.p.

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Tel.: Pudsey 2241. E204 G

FOR SALE, 6000 cu. ft. capacity open top Cast Iron Sectional Water Tank.—BOX No. E1106, "The Engineer." G

NEW 4750kW. Brown Boveri GAS TURBINE-DRIVEN ALTERNATOR SET, 11,000 volts, 3-phase, 50 cycles ; with all ancillaries, spares. Manufactured 1953. Reply.—BOX No. E7782, "The Engineer." G

Classified Advts. continued on page 10

FOR SALE

Edwards

DE BERGUE No. 34A Automatic Geared Multiple Punching Machine, capacity 87in. wide by 31ft. long, punches 18 holes 5/16in. diameter in ¾in. plate or 6 holes 1 3/16in. diameter in 1in. plate at one stroke. Weight about 42¼ tons.
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NEW TRUMPF Model OMS401/402 Electric Throatless Shearing Machine for bench mounting, suitable for cutting all kinds of straight or irregular shapes in mild steel up to 7 S.W.G. (·18in.) mild steel, with flexible drive and grinding attachment, smallest cutting radius 3¼in., suitable for 400/440 volts, 3 phase, 50 cycles.
SEDGWICK Double Geared Open-Ended Press Brake, pressure 200 tons, capacity 12ft. by ¼in., depth of gap 18in., stroke 3in., motorised 400/3/50. Weight about 15 tons.
NEW TYPE SKG203, Open-Ended Undercrank Guillotine, capacity 80¼in. by ¼in. mild steel, gap depth in open ends 6in., motorised 400/440/3/50, automatic hold-down, all gauges and extended side squaring gauge, back gauge operated by hand-wheels through rack and pinion mechanism. Weight about 40 cwt.
ROBERTSON Geared Section Rolling Machine, motorised 400/3/50, between bearings 16½in., seven pairs of adjustable rolls, 14in. between centres of each pair. Weight 6 tons.
Photographs of the above are available.

MACHINE TOOLS, NEW AND USED
Of Every Description. Attractive prices.

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DIESEL ALTERNATOR SETS

600 kVA BRITISH POLAR/A.S.E.A., engine vert., 5-cyl., 2-stroke, air start, 250 r.p.m., alternator 440/3/50.
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250 kVA DEUTZ/SIEMENS SCHUCKERT, engine 290 b.h.p. vert., 7-cyl., 4-stroke, air start, 500 r.p.m., alternator 6300/3/50.
Two 94 kVA BLACKSTONE/E.C.C., engine GPV,3, 3-cyl., 4-stroke, air start, 600 r.p.m., alternator 440/3/50.
94 kVA BELLISS & MORCOM/L.D.C., engine vert., 3-cyl., air start, 600 r.p.m., alternator 440/3/50.
Quantity 31·2 kVA CUMMINS Mobile Sets, engine series "A" 6-cyl., 4-stroke, electric start, 1000 r.p.m., alternator 440/3/50. Mounted on pneumatic tyres.

GEORGE COHEN,
SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070 ; and
STANNINGLEY, NR. LEEDS.
Tel.: Pudsey 2241. E201 G

FOR SALE

2-ton Jones Super 22 Diesel-driven Mobile Crane on pneumatics with 24ft. jib.
3-ton Jones Super 40 Diesel-driven Mobile Crane on pneumatics with 30ft. jib.
5-ton Smith Steam Crane, new 1949, with 35ft. jib.
5-ton Morris Versatile Diesel/Elec. Mobile Crane on solids.
6-ton Ransomes and Rapier Standard Diesel/Elec. Mobile Crane on solids.
6-ton Ransomes & Rapier Super Petrol or Diesel/Elec. Mobile Crane on solid rubber tyres.
Priestman "Wolf" with skimmer and back acter equipments.
Ransomes and Rapier 440 Excavator, with face shovel and dragline equipments.
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Tel.: Simonswood 2634–5–6.
E7724 G

NEARLY NEW GAS PRODUCER PLANT by Power Gas Corp. Capacity 50,000 cu. ft. per hour on anthracite. Complete with supporting structure and equipment.—BOX No. E7799, "The Engineer." G

NEW 4200 KW STEAM TURBO-ALTERNATOR SET for 270 lb. p.s.i. steam, 680 deg. F., 3300 volts, with Switchboard and 1200 kVA. Transformer to 440 volts.—BOX No. E7495, "The Engineer." G

12FT. BY ¾IN. BENNIE FOLDING MACHINE for sale. Motor-driven, Swing Beam, Universal Folding, Rounding and Box Forming Type. Max. lift of top beam 18¼in. Adjustment to bed and folding beam 8in. Smallest trunk formed over beam 18in. by 18in. Largest tube formed 16in. diameter. Gearbox drive with lever control to reversing friction clutches, operating all beams. Safety slipping clutch between gearbox and main drive shaft. Weight about 14 tons.—Full details, illustrations, &c., from F. J. Edwards Limited, 359, Euston Road, London (Euston 4681) or 41, Water Street, Birmingham, 3 (Central 7606). E7808 G

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RECONDITIONED MACHINERY FOR SALE

STEAM BOILERS.—Cochran Vertical (New), 8ft. 6in., 8ft., 7ft. 6in. 7ft. and 6ft. in dia., 100/150 lb. w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic, 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstube, all sizes.
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200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
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RAILWAY MATERIAL.—Peckett 14in. by 22in. and 7in. by 12in. Steam Locos.; 3 miles 20 lb. Track, 24in. gauge bogies, turnouts, locos., &c.
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106FT. SPAN, 80FT. CLEAR HEIGHT UNDER GIRDERS.

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Main hoist ... ... 25 tons—16ft. per min.
Auxiliary hoist ... ... 10 tons—40ft. per min.
Cross traverse... ... ... 200ft. per min.
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Power supply, 400/440 volts, 3 phase, 50 cycles.

Approximate total weight of crane 122 tons. All weatherproof enclosures.
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Woolwich Industrial Estate, London, S.E.18.
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SEAMLESS, STAINLESS, STEEL TUBING, all usual sizes and gauges ; 6 weeks' delivery.—BOX No. E1100, "The Engineer." G

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HIGH CLASS
VERTICAL BORERS
AVAILABLE FROM STOCK

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HARTMAN 43½in., motor drive, hexagonal turret head and side head, with square toolpost, table dia. 39½in., max. swing 43½in., height admitted 27½in., 16 speeds, 3–52 r.p.m.
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RICHARDS 7ft., motor drive, two swivelling tool rams, both arranged for taper turning on cross rail, power rise and fall to cross rail, table dia. 72in., max. swing 86in., max. height under cross rail 45in., max. height under tool holders 36in., speed range 1·19–25·18 r.p.m.
RICHARDS 8ft., motor drive, two swivelling tool rams on cross rail, power rise and fall to cross rail, table dia. 87in., maximum swing 96in., maximum height under cross rail 62in., 12 table speeds, h.p. motor 30.
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Heenan and Froude 2000 h.p. Dynamometer : £250.
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DEPTEX
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E1122 G

600
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AIR HYDRAULIC ACCUMULATOR AND PUMPING PLANT

comprising five-Bottle Accumulator, draw-off capacity 225 gallons at 3000 lb. per sq. inch, with three 275 h.p. Horizontal Three-Throw Hydraulic Pumps, full electronic control equipment.

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AIR COMPRESSORS

1640 c.f.m. BELLISS & MORCOM, vert., 2-crank, 2-stage, double-acting, water-cooled, W.P. 75 lb. sq. in. at 333 r.p.m., intercooler between stager and aftercooler, direct coupled 295 H.P. auto. synch. motor by Crompton Parkinson, 400/3/50, 0·8 p.f., with control equipment.
Two 461 c.f.m. INGERSOLL RAND, type ES-X, horiz., encl. single-cyl., single stage, double acting, water-cooled, W.P. 100 lb. sq. in. at 325 r.p.m.
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TWW

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E213 G

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FOR SALE

Designed for 190-ton on 58ft. span, 72ft. lift, by Sir Wm. Arrol and Co., Ltd., now arranged for 106ft. span, capacity 90 tons. Can be altered to any intermediate span with equivalent lifting capacity. Weight 334 tons.

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GARDNER 50in. HORIZONTAL MOTOR-DRIVEN DISC GRINDER, with wheel dresser and dust extractor ; motor 20 H.P.

F. J. EDWARDS, LTD.,
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EUSton 4681. E7632 G

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One 1500kW Bellis-Lancashire Steam Turbo-Alternator Set, complete with Jet Condensing Plant.
Steam pressure 150 lb. per square inch with 100 deg. F. superheat.
Alternator—direct-coupled 1875kVA. 1500kW, at 0·8 power factor, 3300 volts, 50 cycles at 3000 r.p.m.
This set, which was installed in 1925, has been in regular service until recently and is in excellent working condition.
This Plant is surplus to our requirements as it is being replaced by a larger set.—BOX No. E7783, "The Engineer." G

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10,000-ton Hydraulic Forging Press, Pumps and Accumulator (Unused).
4000-ton Hydraulic Bending Press, upstroke, table 18ft. 6in. by 10ft., with Pumps and Accumulator (Unused).
2650-ton Hydraulic Rubber Sheeting or Belting Press, platens 18ft. 4in. by 7ft. 4in., with Pump Unit.
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1200-ton Horizontal Extrusion Press.
1400-ton Downstroke Forging Press by Tangye, bed 7ft. square.
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Many other smaller Presses.

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E7732 G

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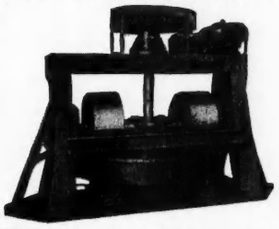

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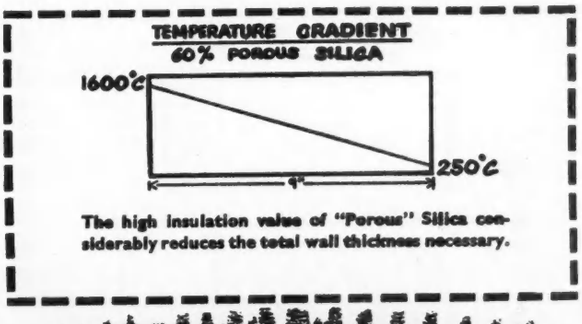

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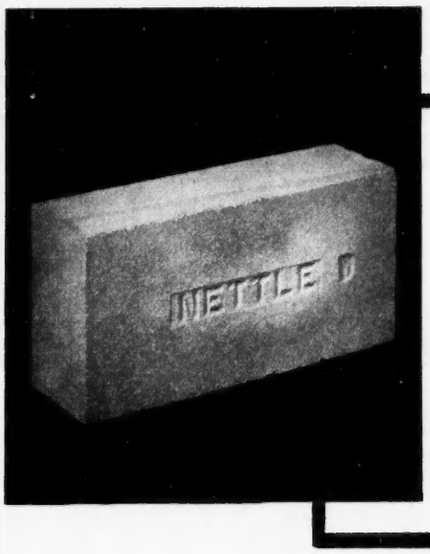
STEIN *Refractories* NETTLE D



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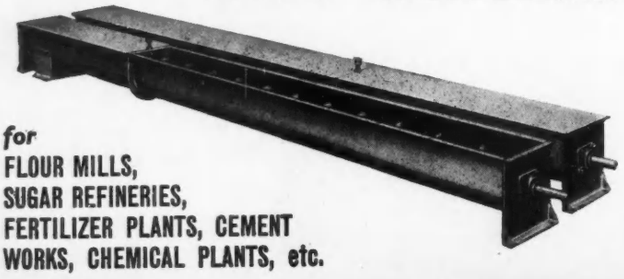

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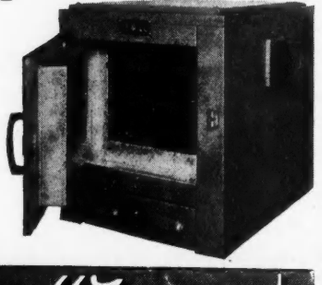

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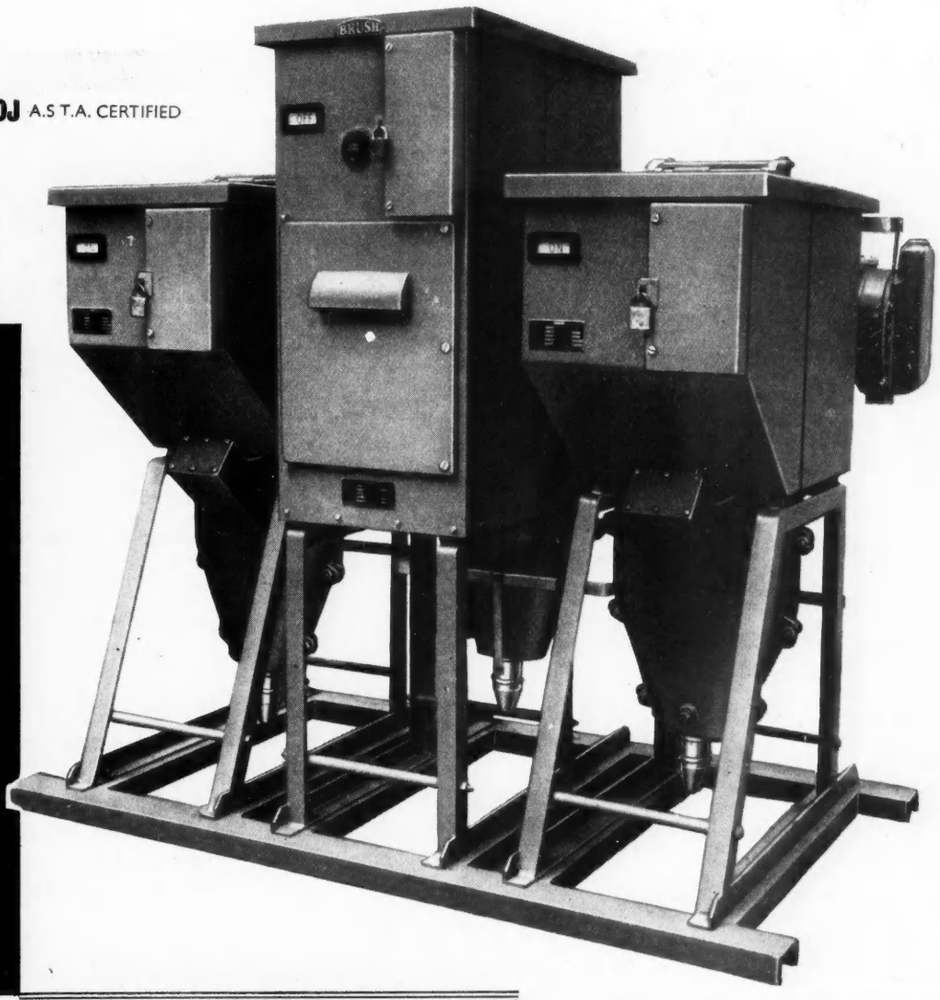

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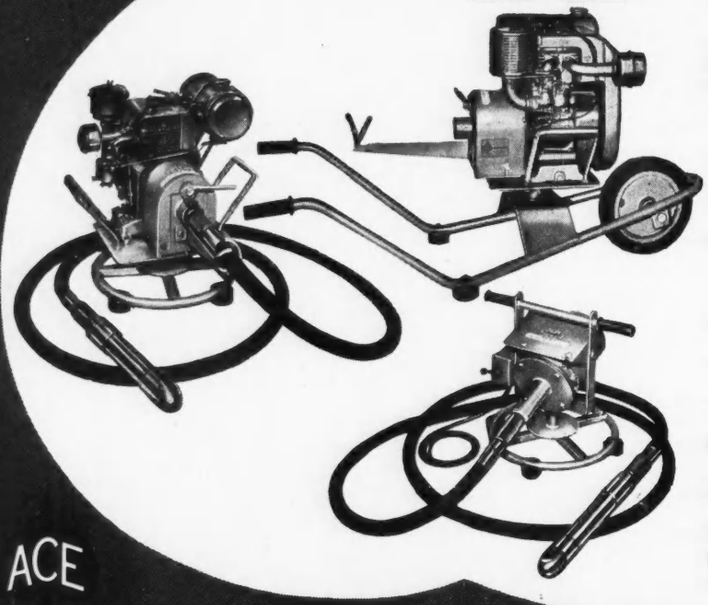

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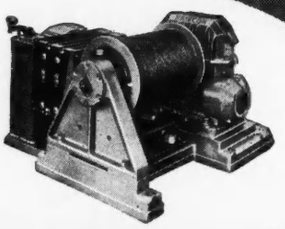

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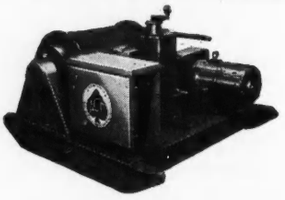

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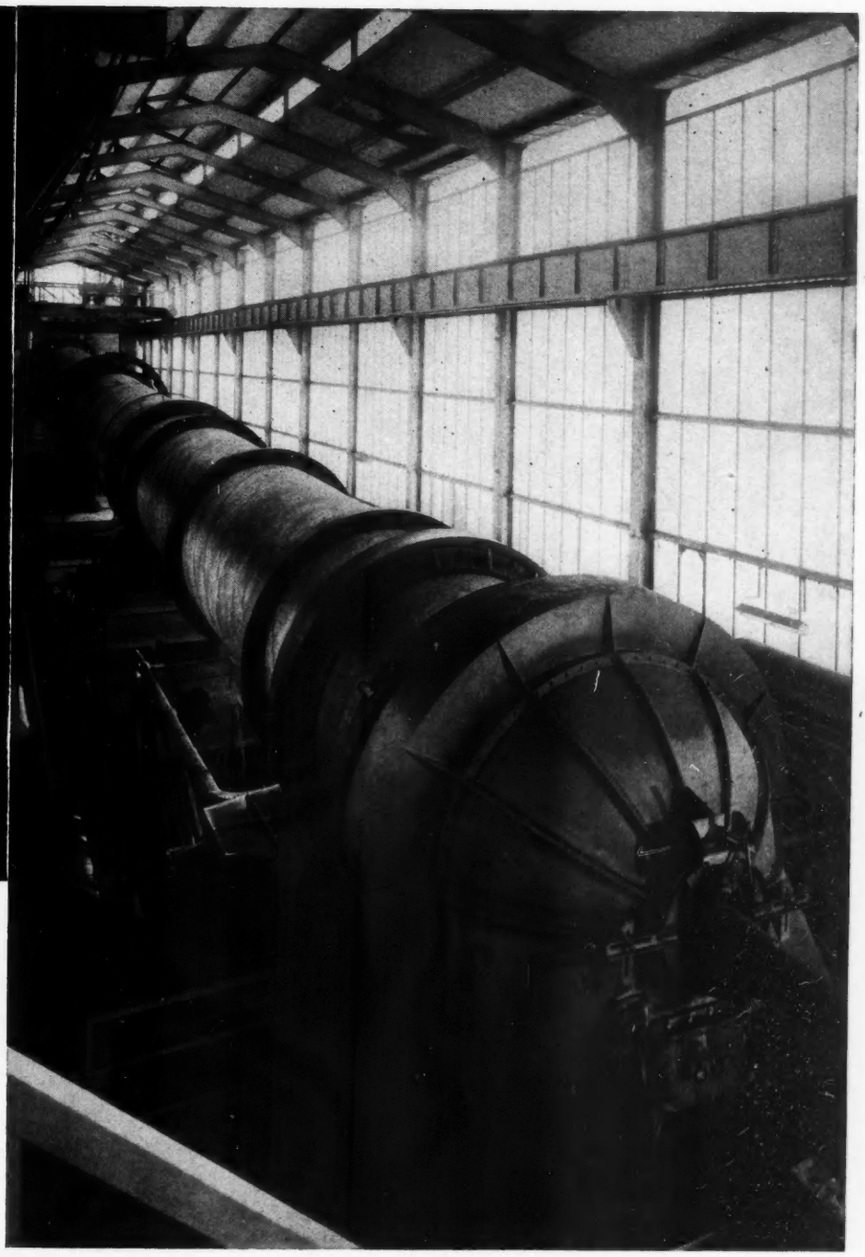

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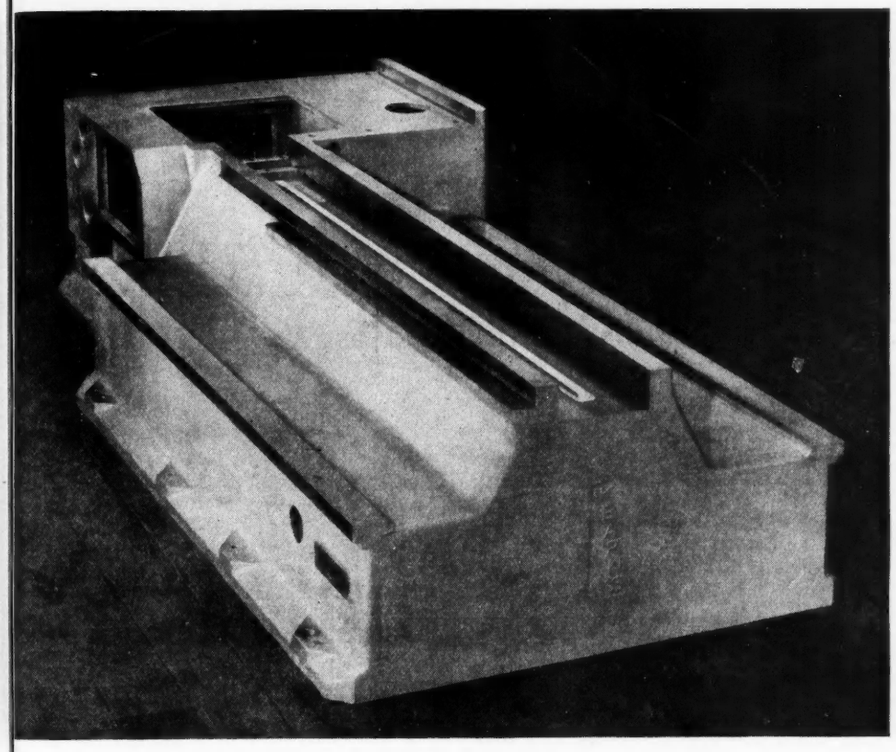
*OPTIMETRIC

TRB

TOOL ROOM BORER



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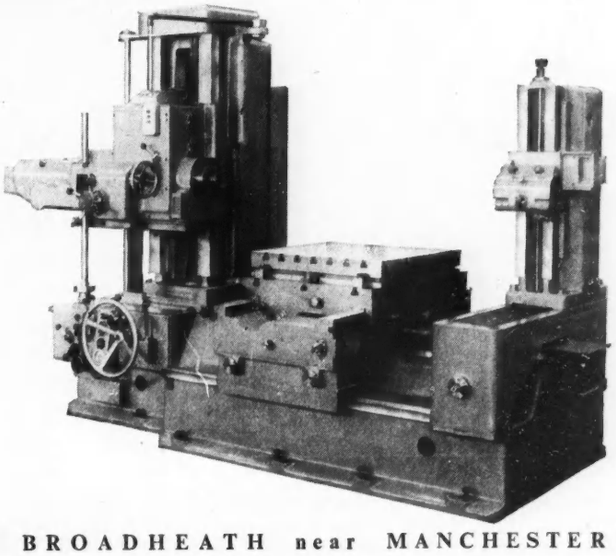

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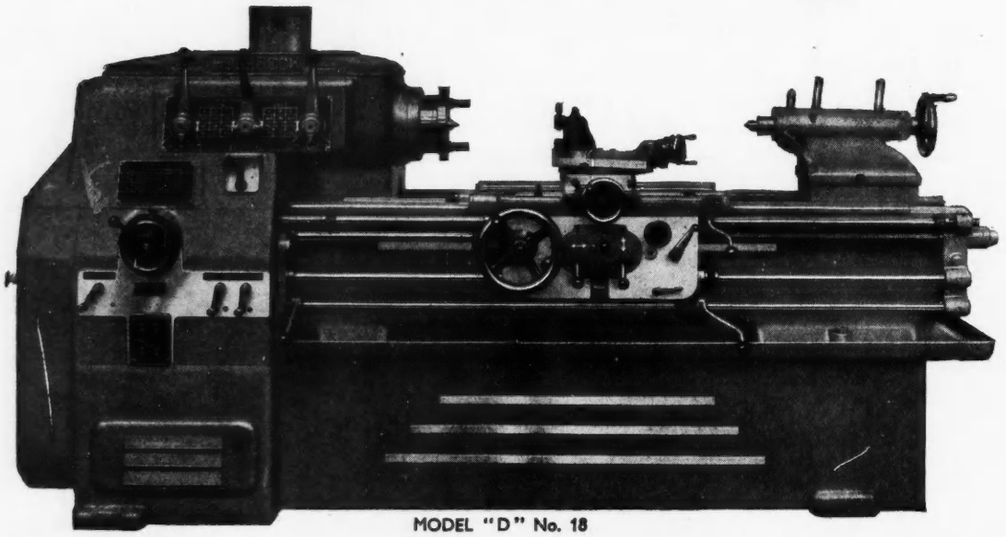

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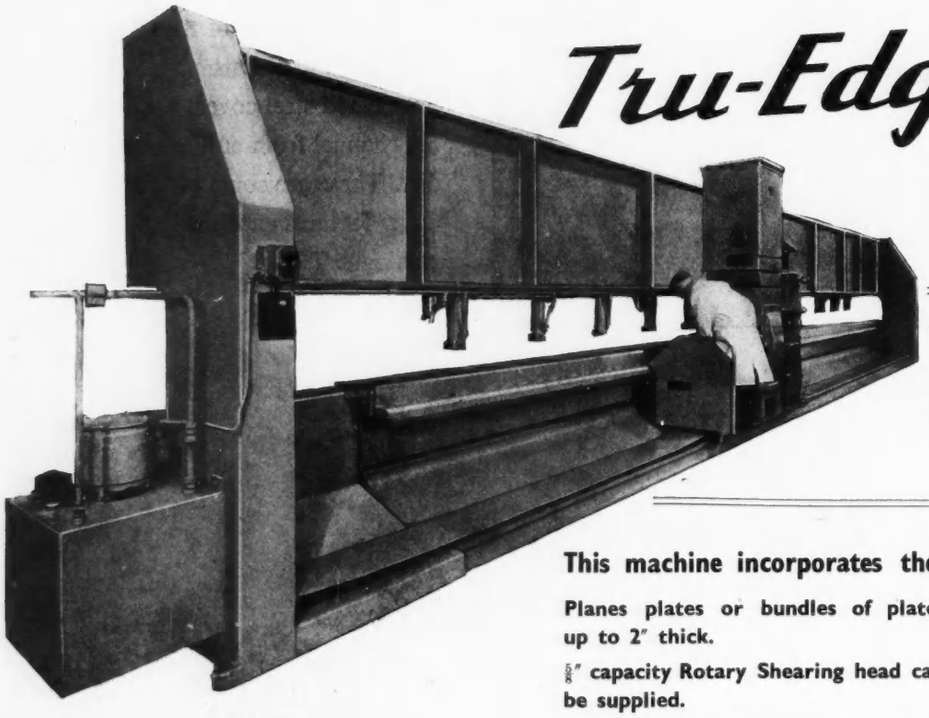

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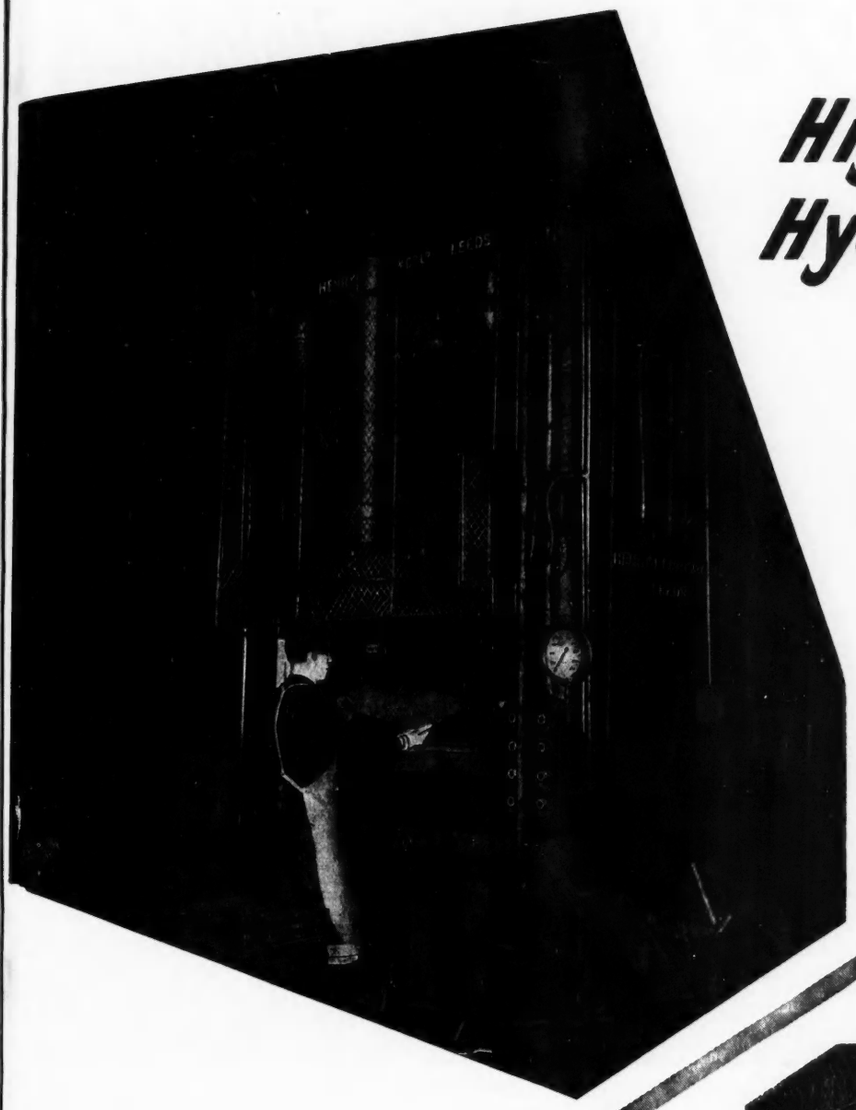

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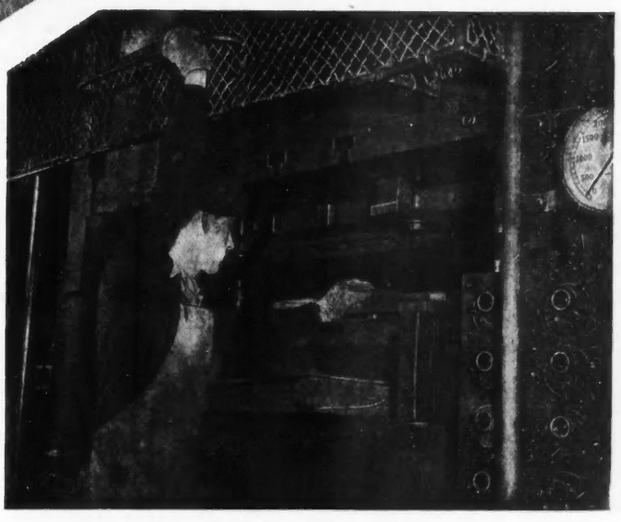

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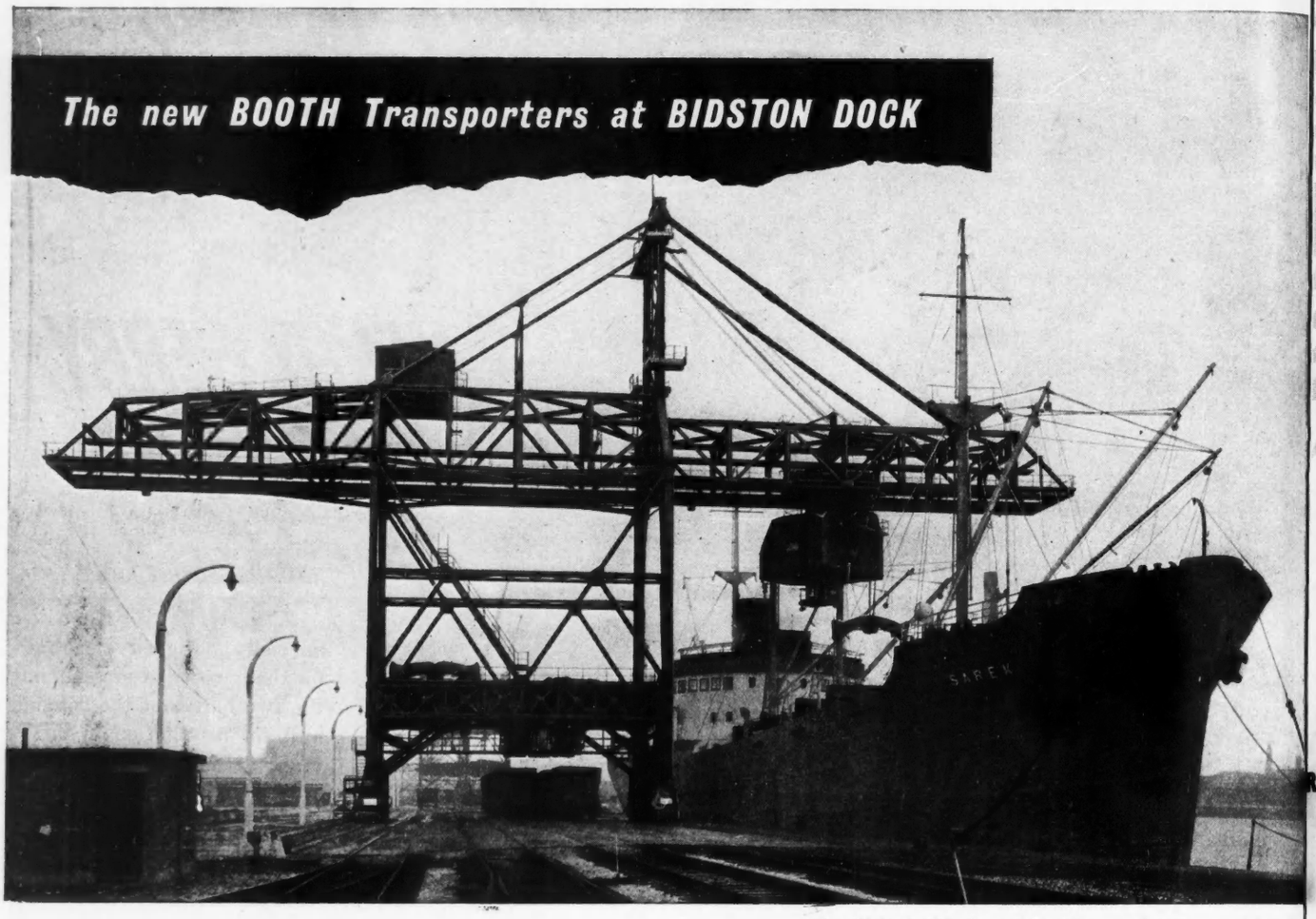

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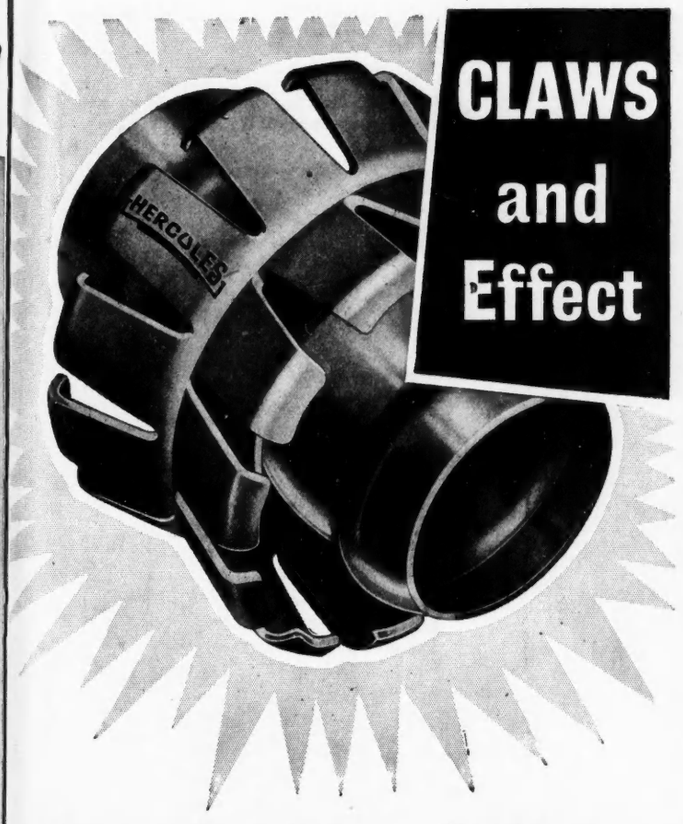

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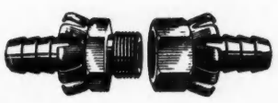

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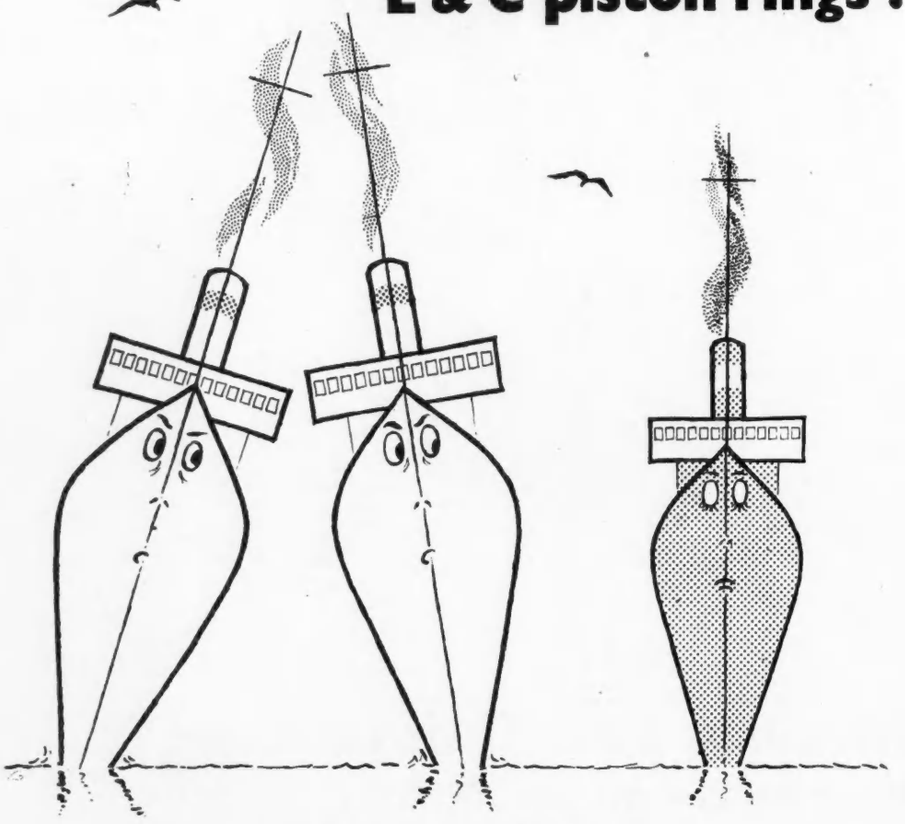

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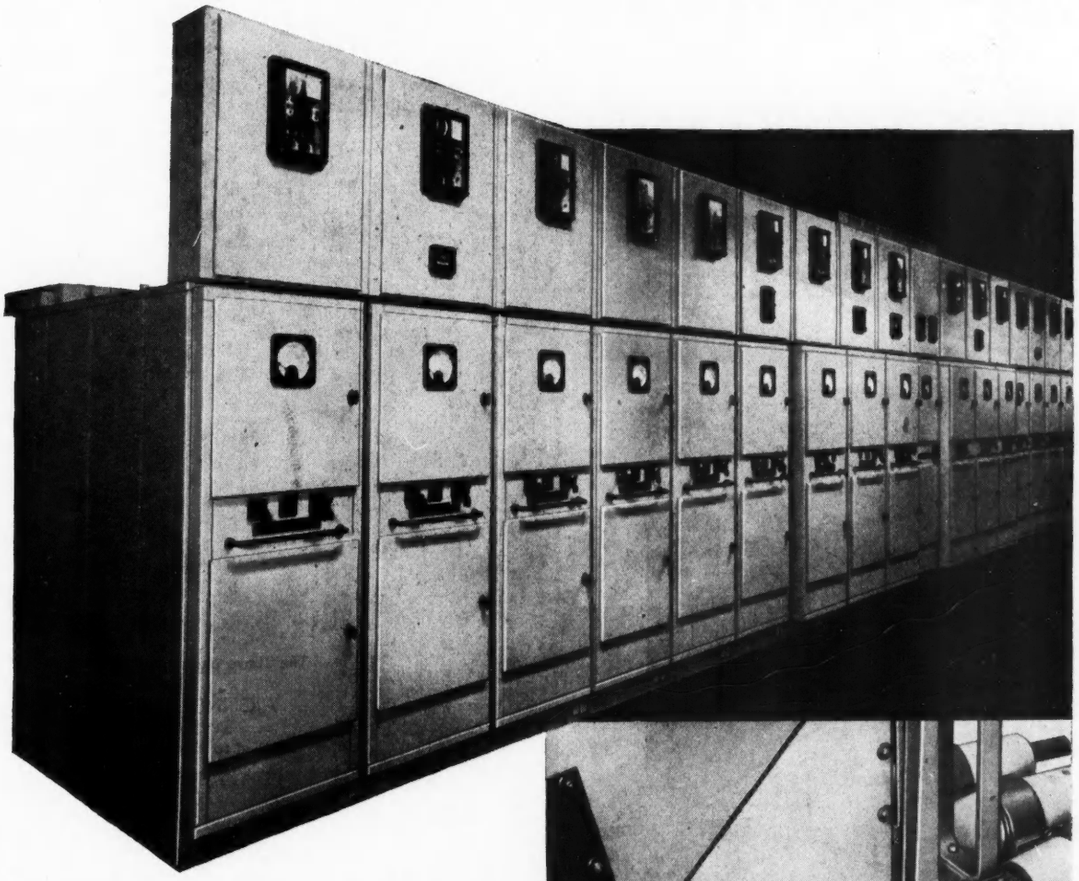
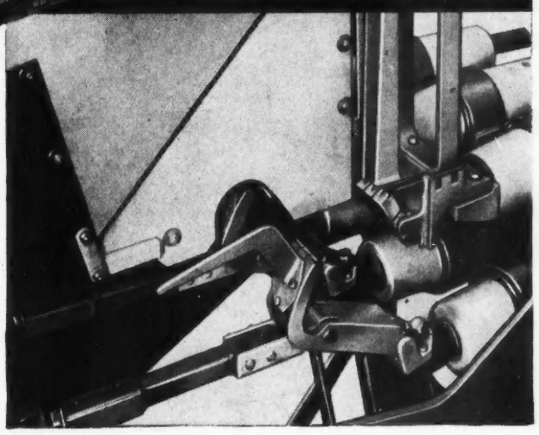
for Power Station auxiliaries





Eighteen 3·3-k.V. Switchboards, comprising in all two hundred and one BTH 150-MVA air-break truck-type units are installed at the C.E.A. (East Midlands Division) Castle Donington Power Station.

(top) One of the Boiler House Switchboards.
(right) Details of switch contacts.

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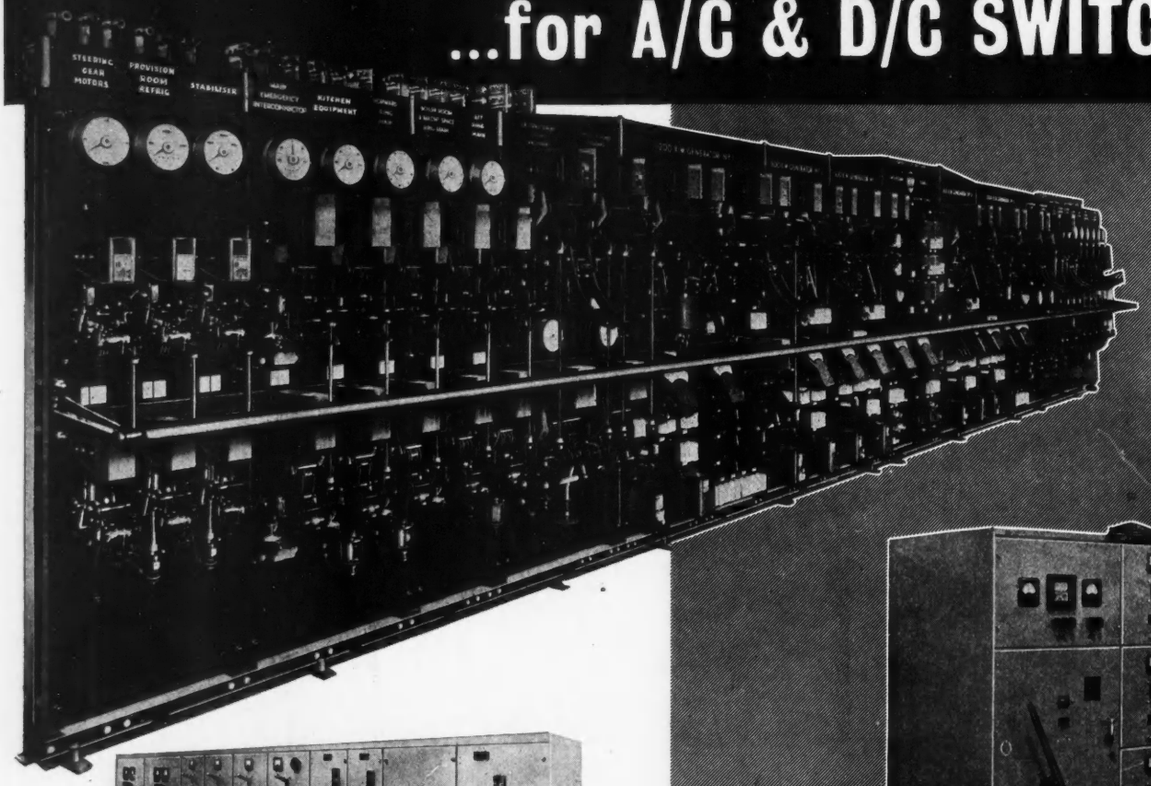
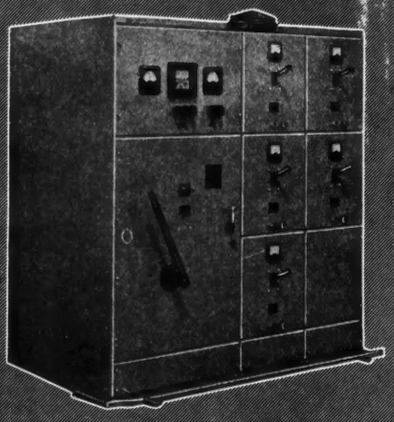
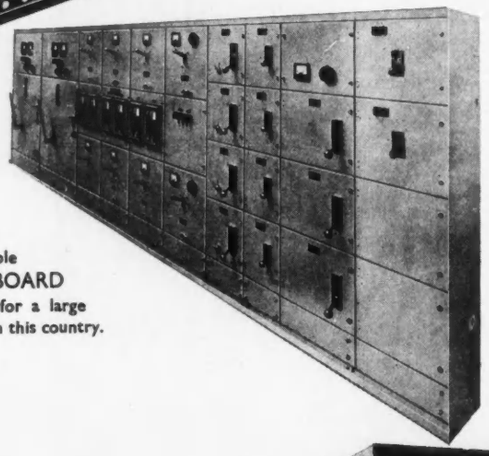
...for A/C & D/C SWITCHGEAR



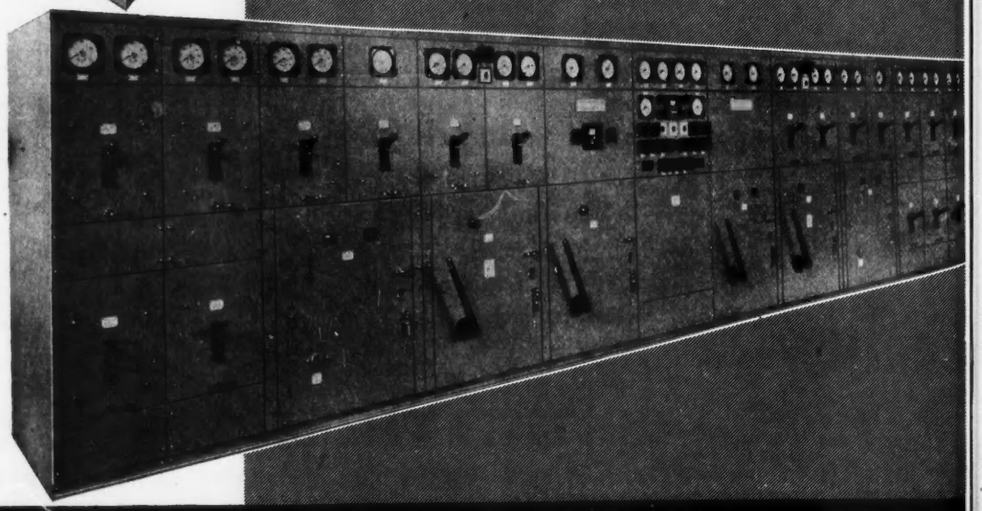
A typical example of an OPEN TYPE D/C SWITCHBOARD as supplied for Steel Works and marine installations.





A fine example of an A/C BOARD constructed for a large steelworks in this country.

The above photograph shows in some detail an A/C INDUSTRIAL TYPE SWITCHBOARD supplied to a large tyre manufacturer.



A D/C CUBICLE TYPE SWITCHBOARD equipped with withdrawable D/C breakers, as supplied to Harbour Boards Steelworks and Atomic Power Stations.

ALL A/C BREAKERS ARE CERTIFIED IN ACCORDANCE WITH B.S.S. 116 & 936 for 25 & 31 M.V.A. at 400 volts.

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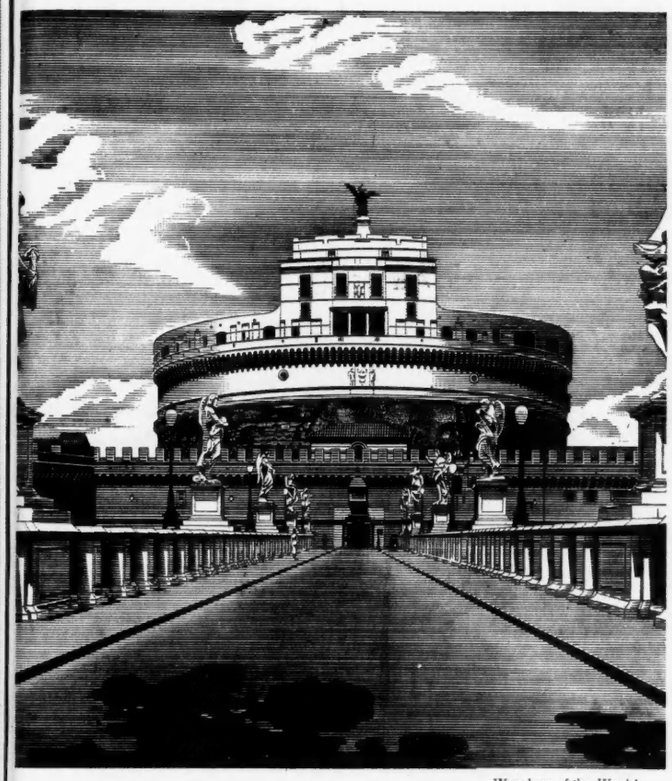

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HADRIAN, Roman Emperor, built this mausoleum for himself and his successors over 1800 years ago. Originally it was encrusted with magnificent marble and the circular wall was crowned by a cone of earth planted with trees. Hadrian also built the bridge which gives access to the tomb. The mausoleum eventually became the medieval citadel of Rome and is now known as the Castle of San Angelo.

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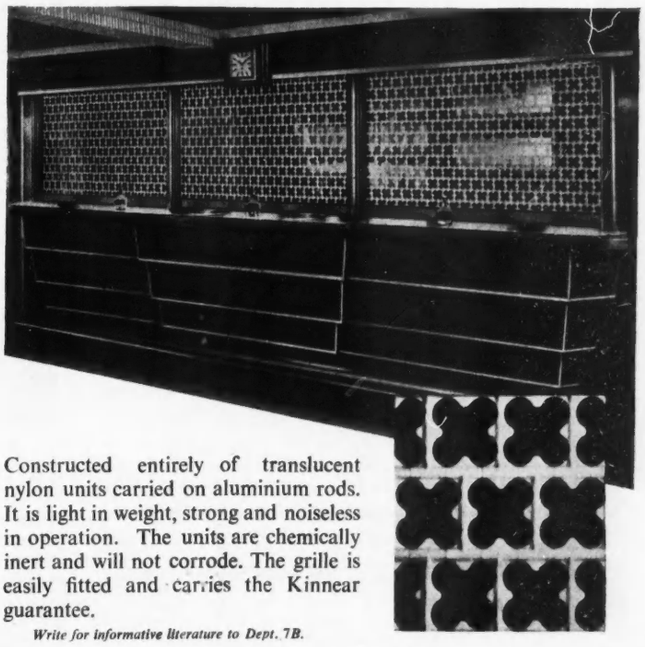

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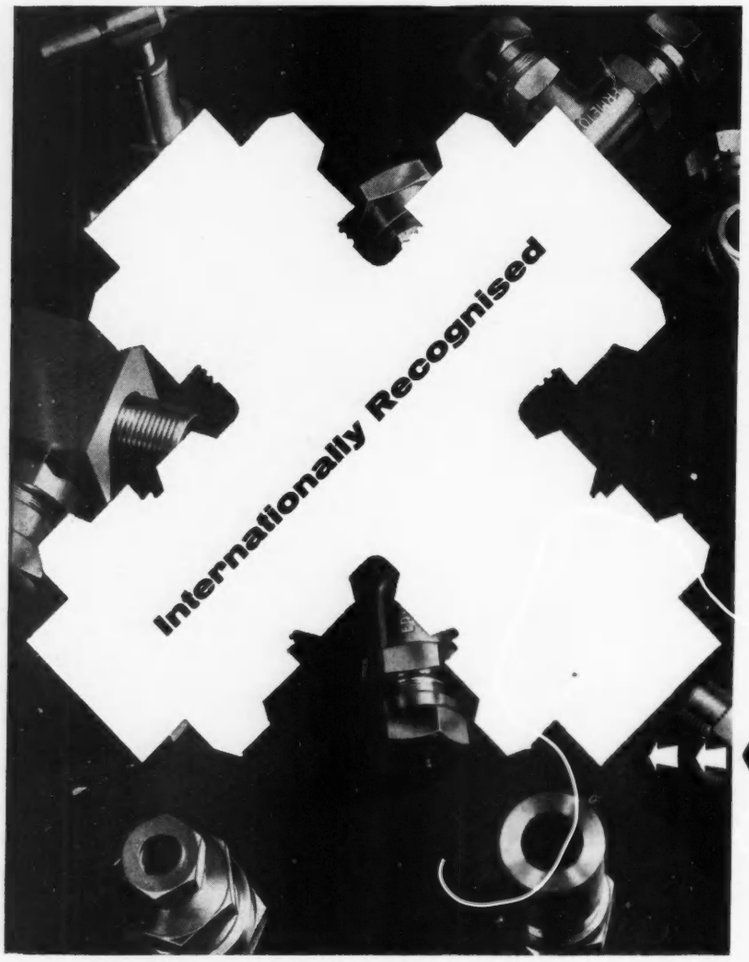

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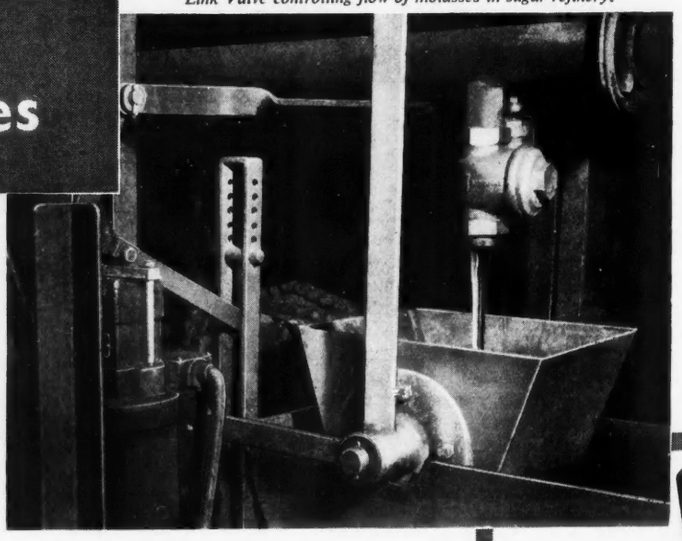
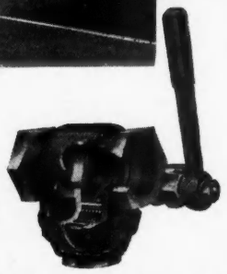
Link Valve controlling flow of molasses in sugar refinery.



The Hopkinson parallel-slide Link Valve is a quarter-turn opening stop valve with a remarkable reputation for easy operation and maintaining fluid-tightness. For handling thick, heavy liquids as well as water, steam and compressed air in a wide variety of industrial applications.



Section showing parallel-slide design.

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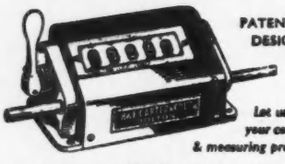

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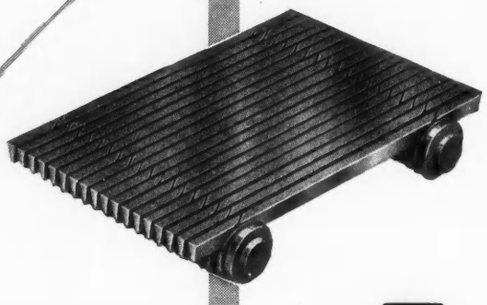

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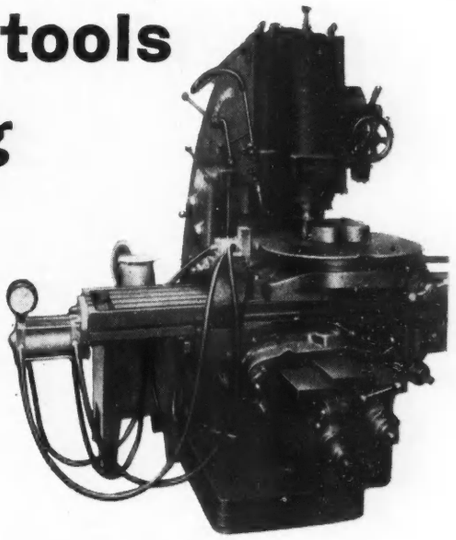
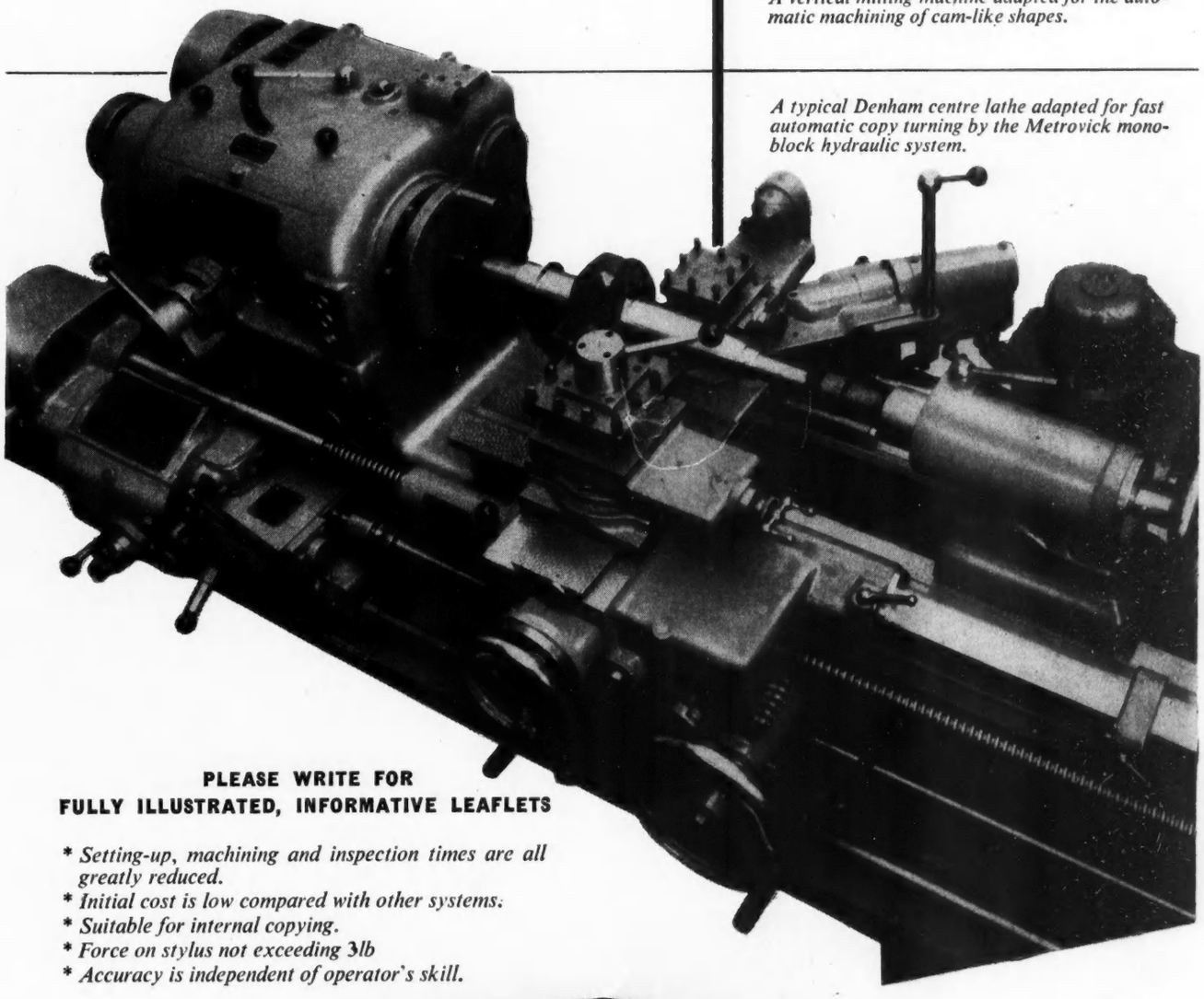


A vertical milling machine adapted for the automatic machining of cam-like shapes.



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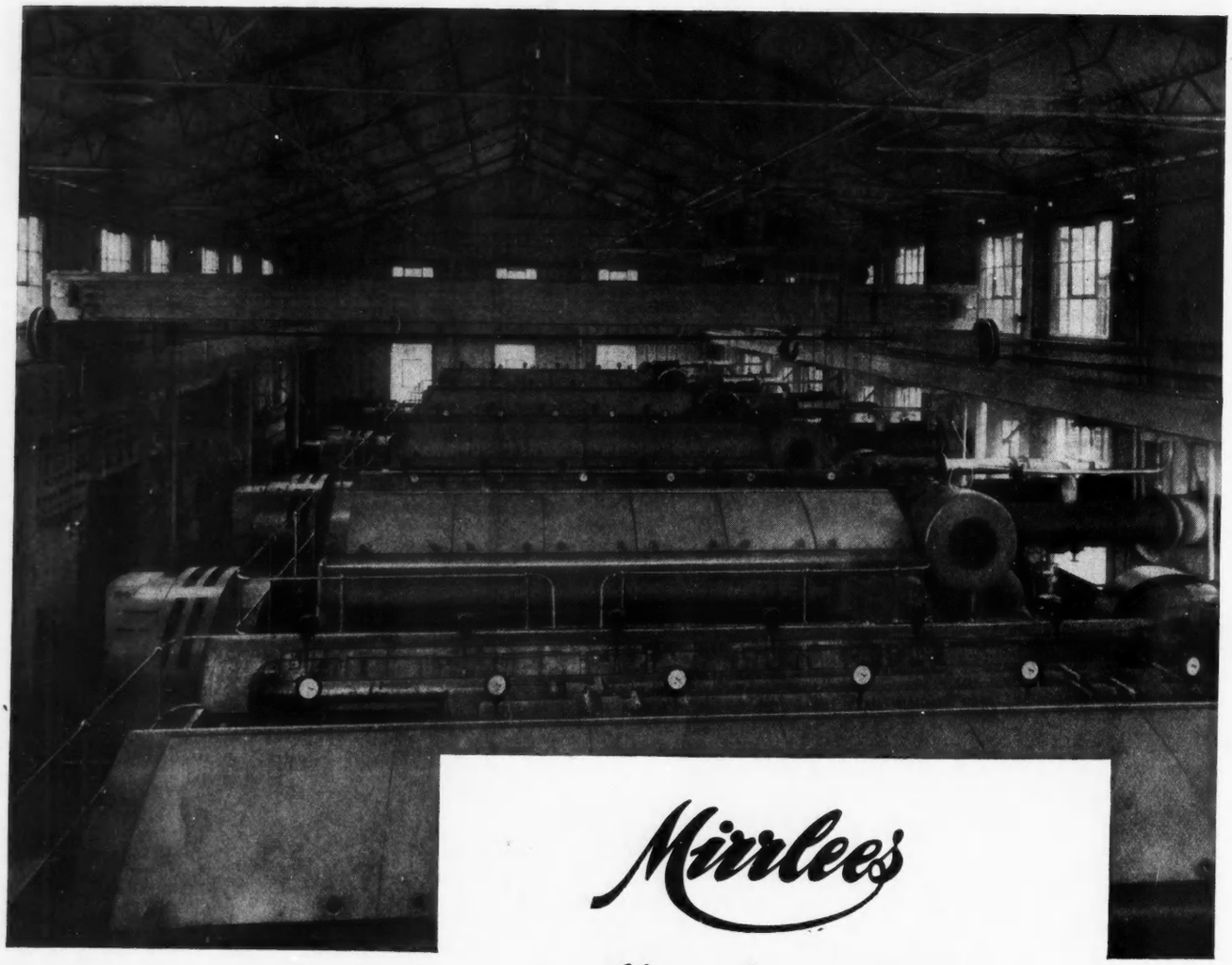

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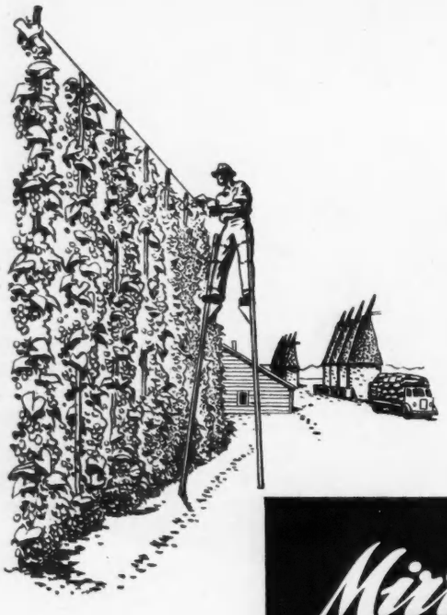

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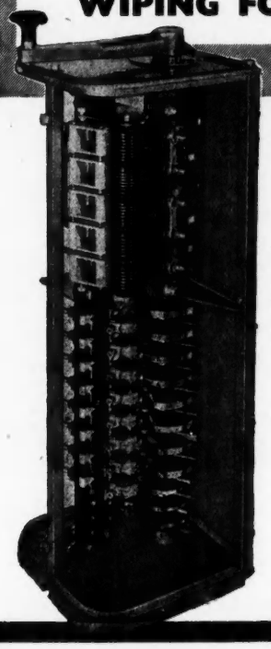

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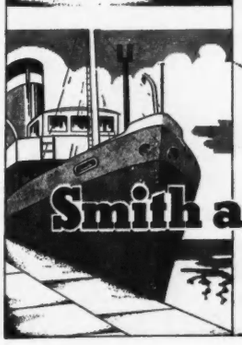

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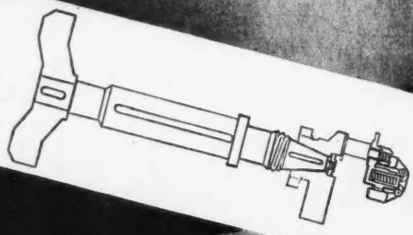
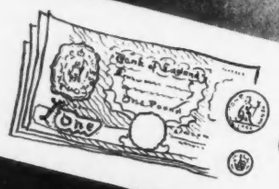


alignment



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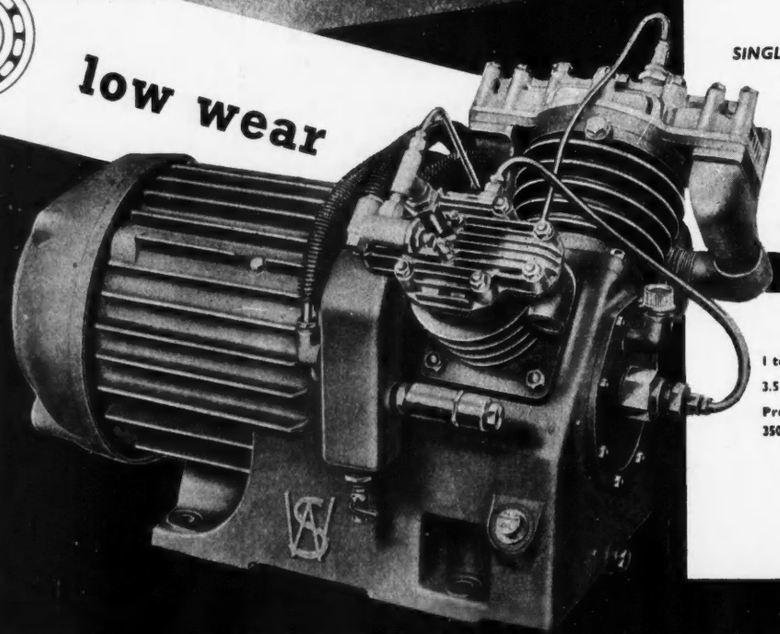

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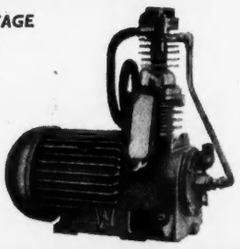

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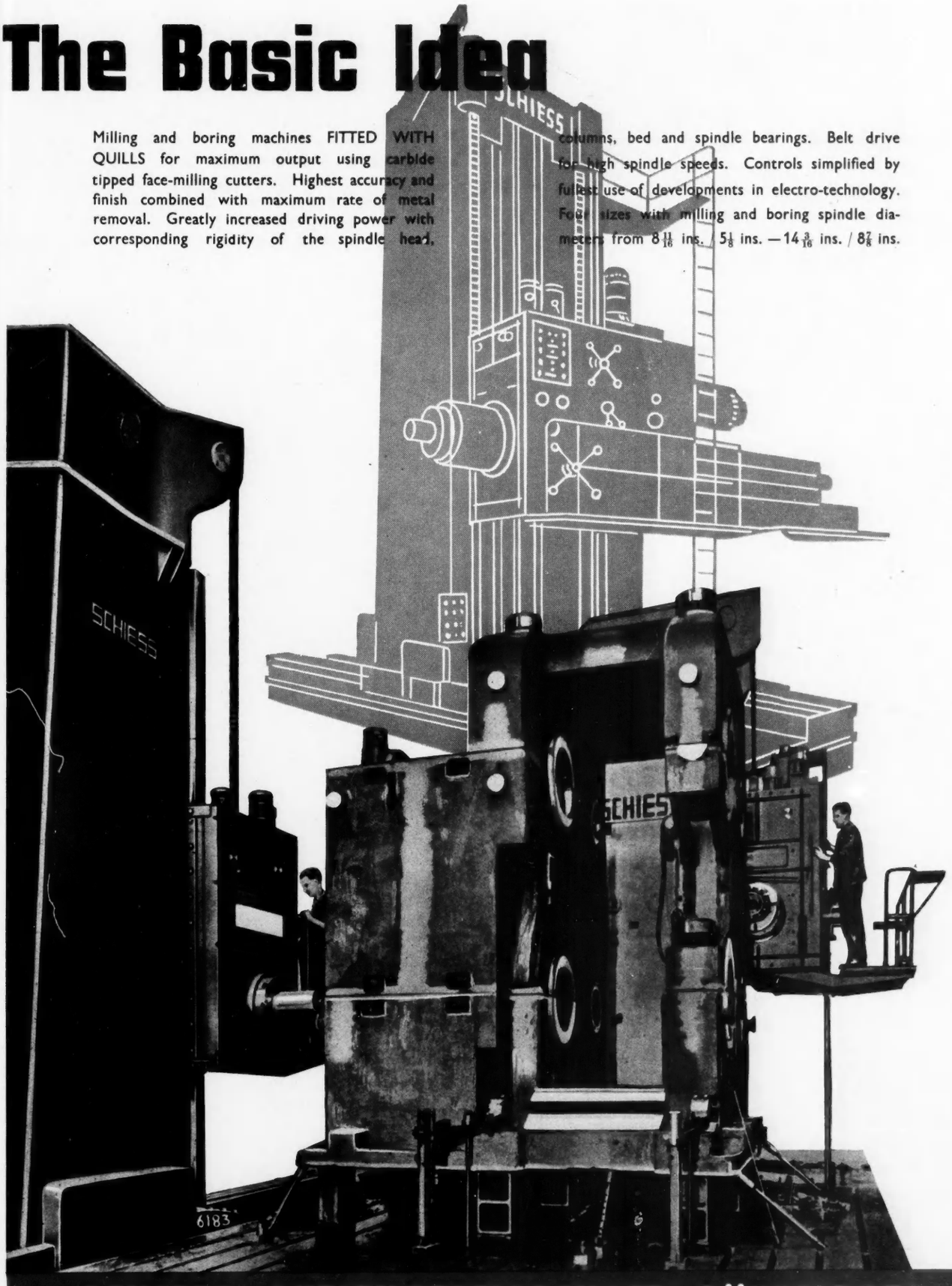

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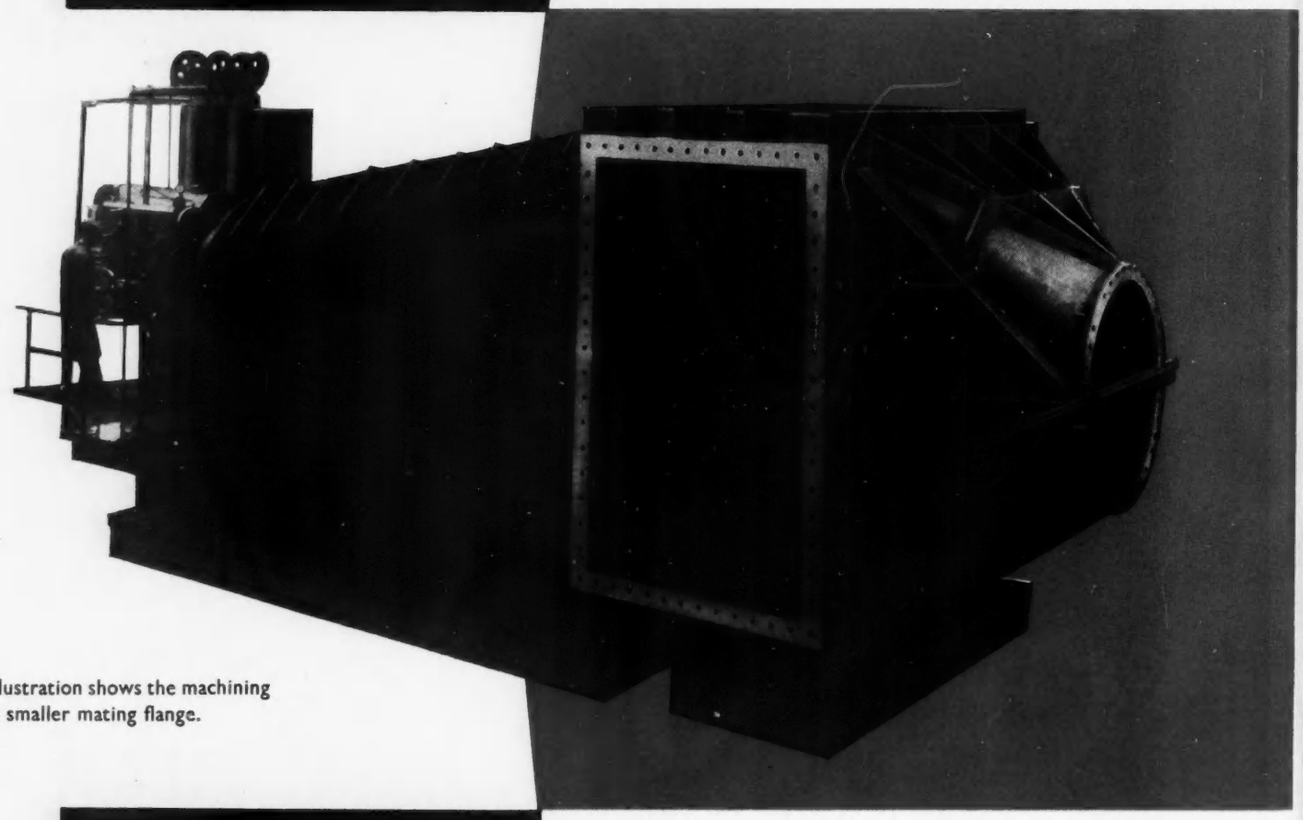

The illustration shows the machining of the smaller mating flange.

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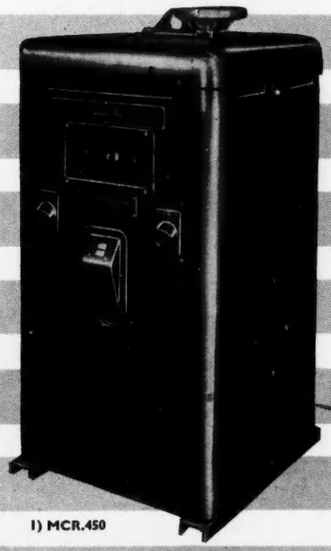

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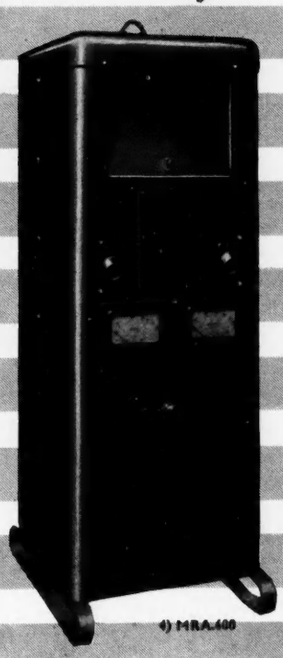
2) MR.375

3) MRS.425



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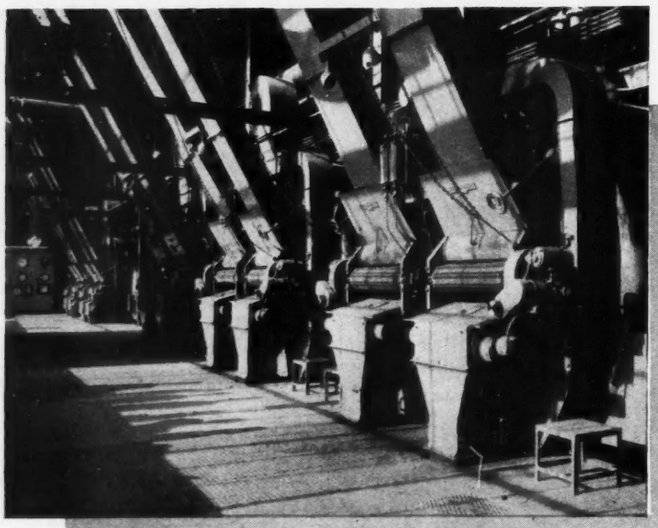

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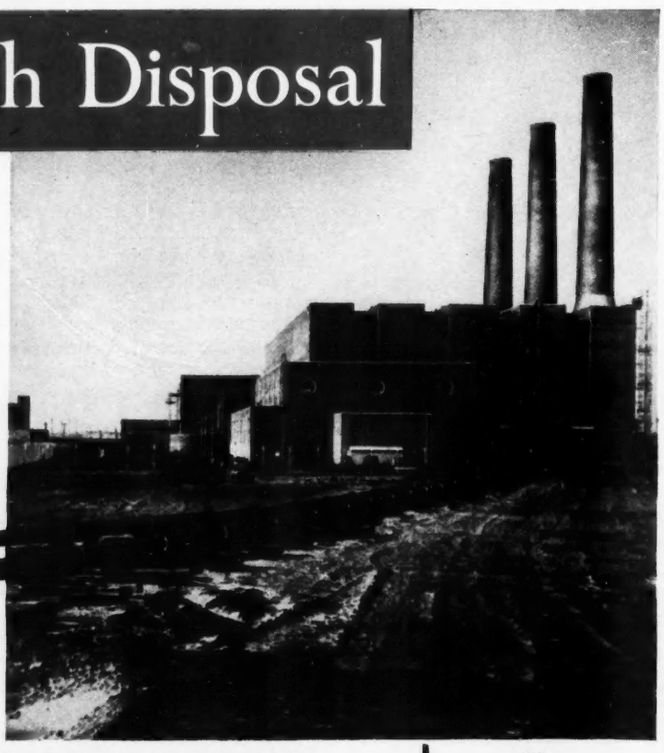

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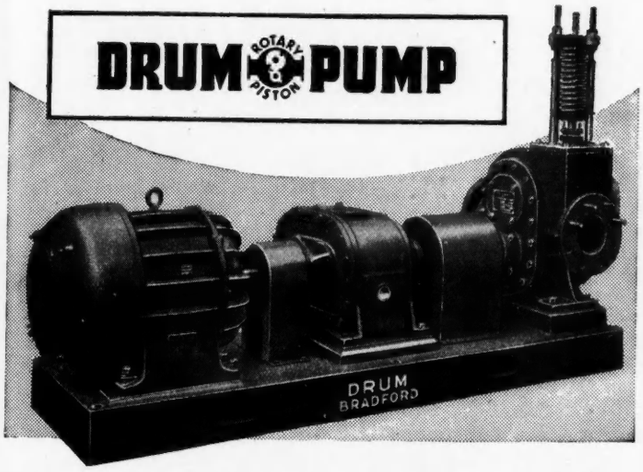

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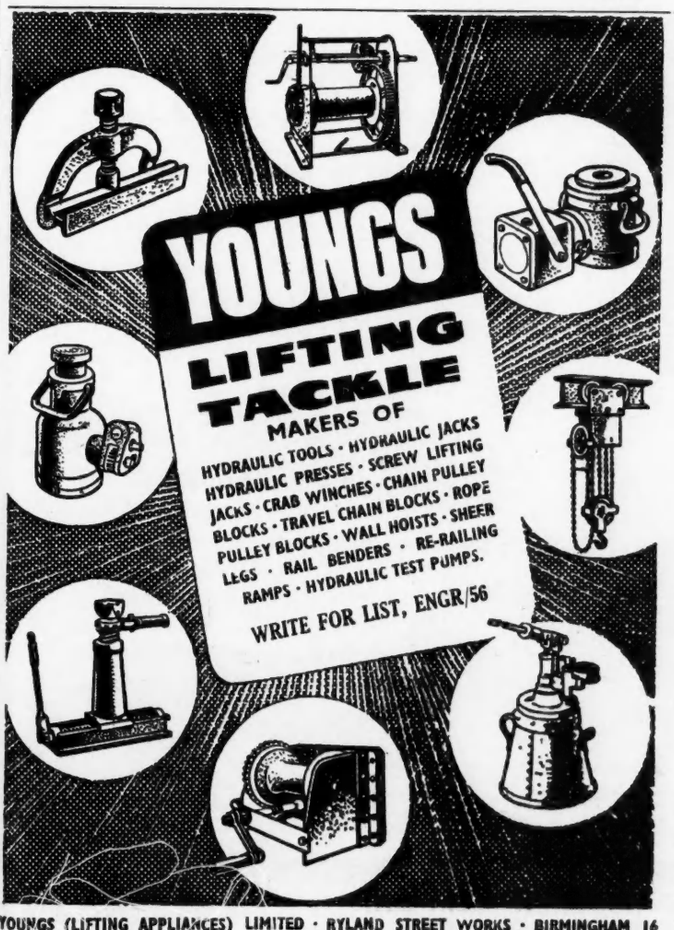
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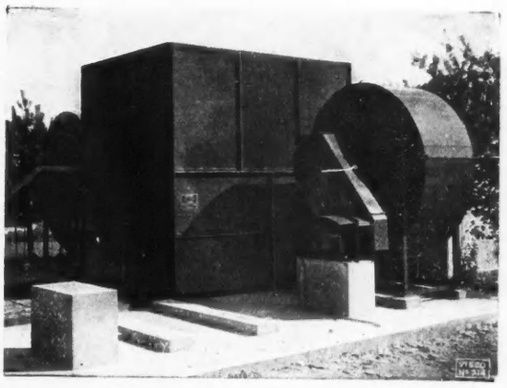

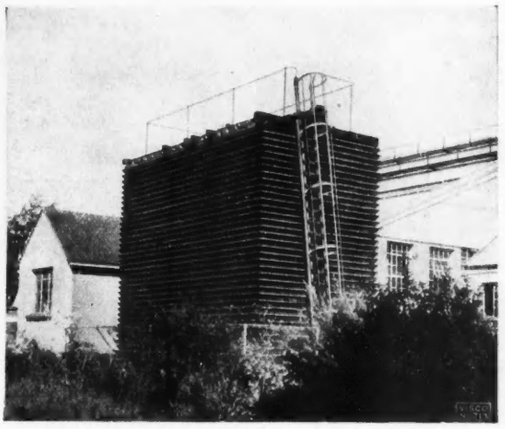

In many industrial establishments in which water is used for cooling air conditioning equipment, diesels, air compressors, process work etc., much water is wasted through being used only once and then run down the drain. About 97% of this water could be saved by installing a "Visco" Steelshell Water Cooler. With this the water used for cooling is recirculated continuously, the only loss—a mere 3%—is due to evaporation. These units can be placed in an odd corner or, if space at ground level is not available, on the roof.

The top photograph shows a "Visco" Steelshell Water Cooler recently supplied to The Marley Floor Tile Co. Ltd. The foundations for a similar unit are shown alongside.
Sizes available from 250 g.p.h. Write for List No. 514.

VISCO
STEELSHELL *Water Coolers*

As well as the steelshell units mentioned above, we make timber-frame and ferro-concrete cooling towers of any capacity. The cooler shown in our second photo is an example of a small natural draught open-type timber-frame tower. This deals with 5,000 g.p.h. and is used for cooling press plates at The Marley Floor Tile Co. Ltd. works.

Consult us on all water cooling matters.

Write for brochure "Visco Water Cooling."

THE VISCO ENGINEERING CO. LTD., STAFFORD ROAD, CROYDON. Phone: CROydon 4181

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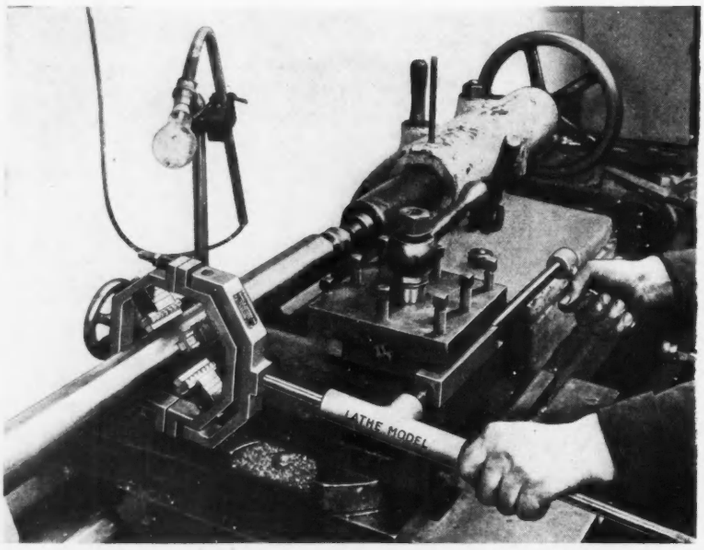

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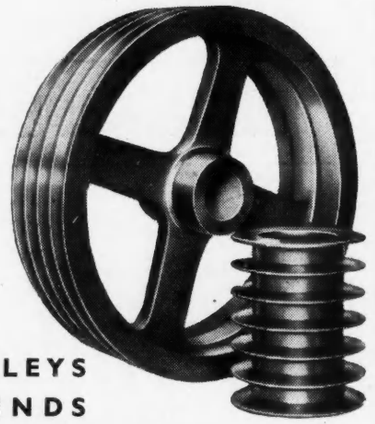

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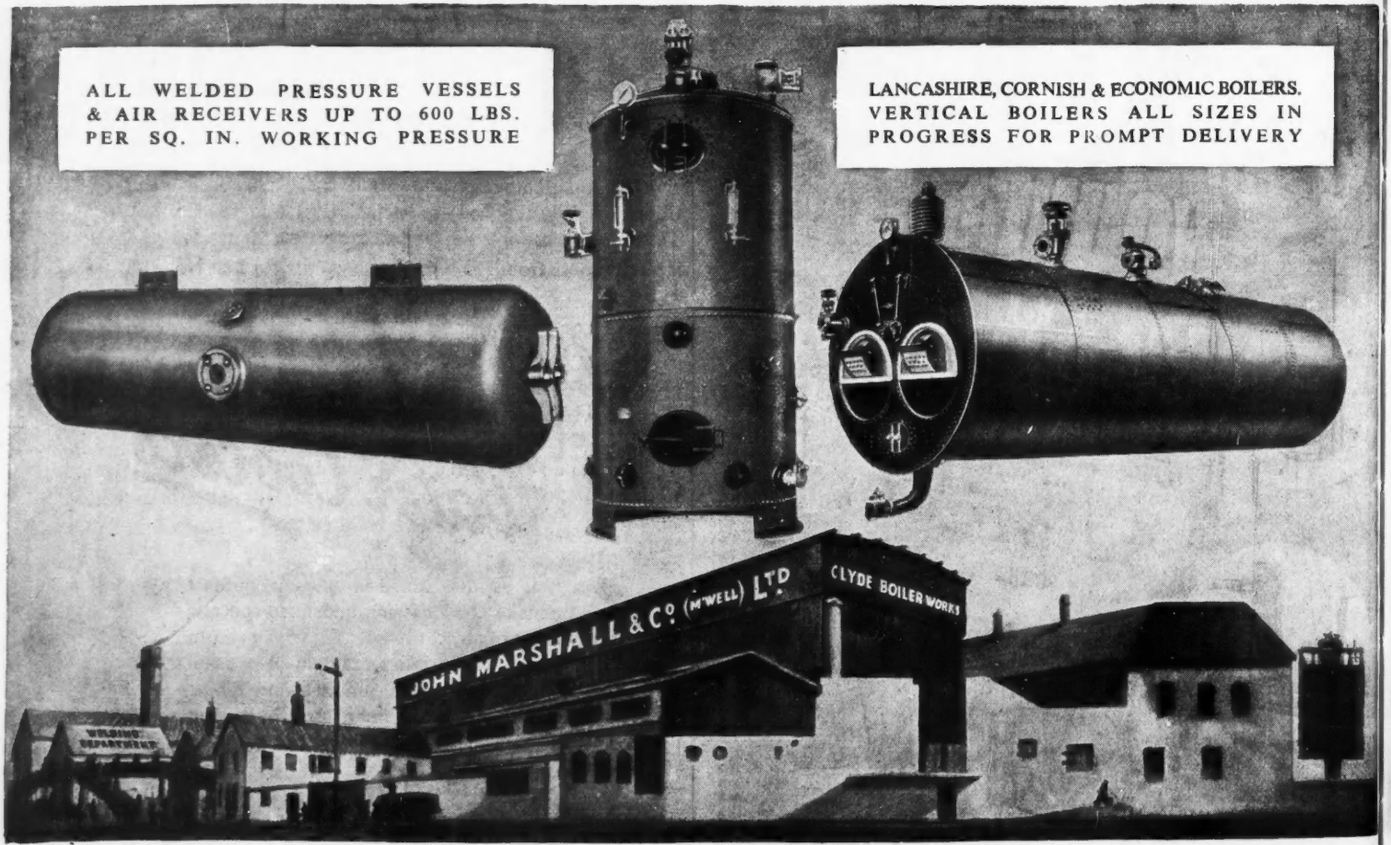

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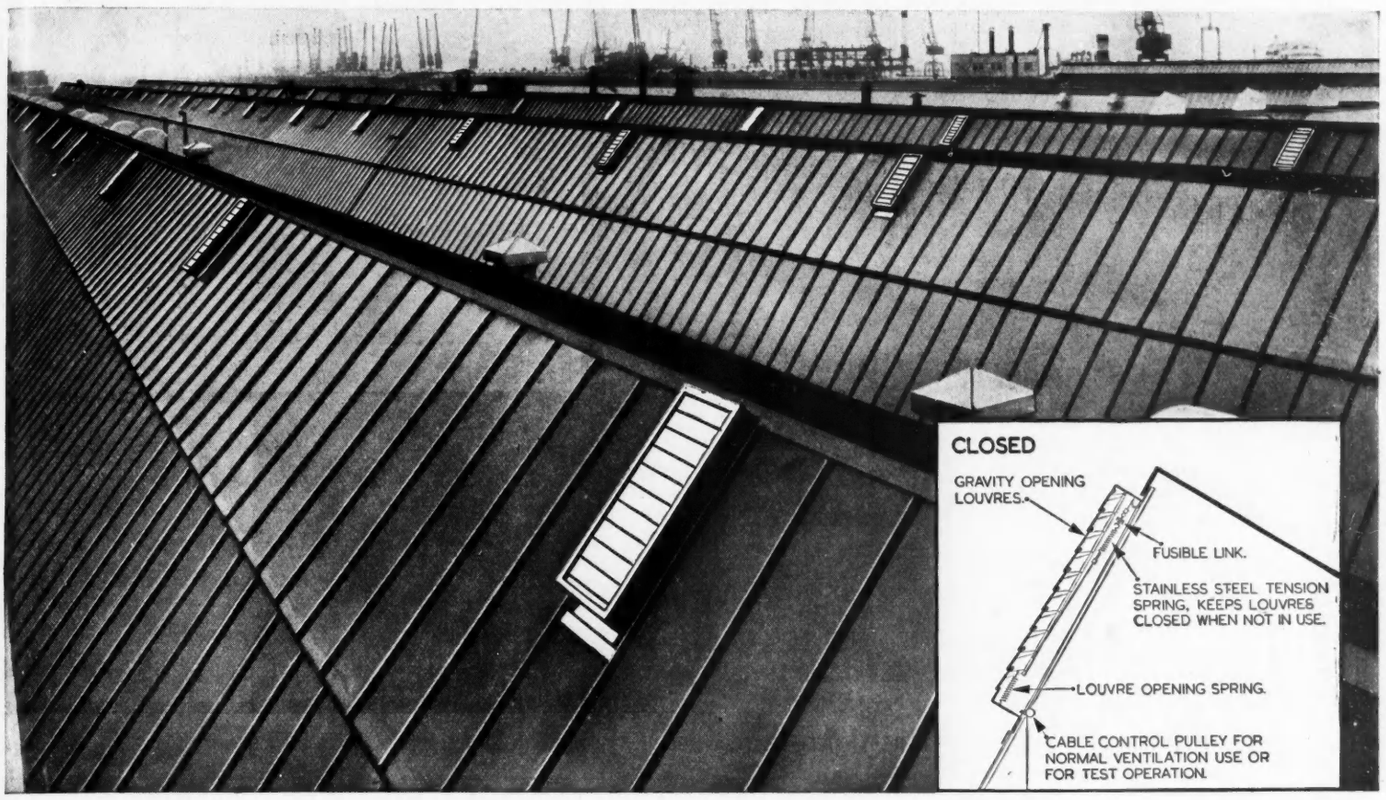
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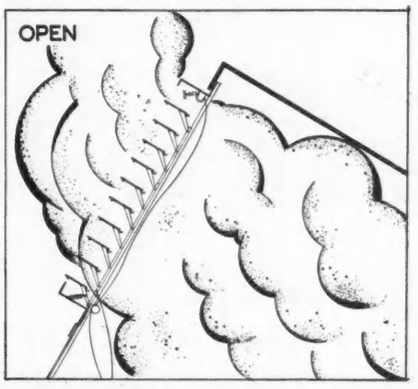
A study of industrial fires in Great Britain and in America has shown that the primary cause for the spread of fire is the super-heated air, smoke and explosive gases trapped under the roof. They build up in heat and intensity from the fire below and cause flash fires. Furthermore, the smoke rapidly extends downwards, entirely filling the premises and preventing the work of the fire fighters.

Colt have successfully solved this problem with the design of the Dual Purpose Fire Ventilator which **provides ventilation during normal conditions and—in the event of fire—functions as a heat and smoke exhaust.**

The installation of heat and smoke exhausts is standard practice in America and is rapidly being adopted by leading industrialists in the United Kingdom. Already, 1,290 Colt Dual Purpose Fire Ventilators have been installed in General Motors buildings in this country.



The insets illustrate the action of the ventilator as a Heat and Smoke Exhaust. In the event of fire, the fusible link fuses, providing Automatic Escape for Super-Heated Air and Smoke.

Write to Dept. S9/8A, for paper "Some Aspects of Fire Protection in Industrial Buildings" by M. J. Reuney, which deals fully with this matter.

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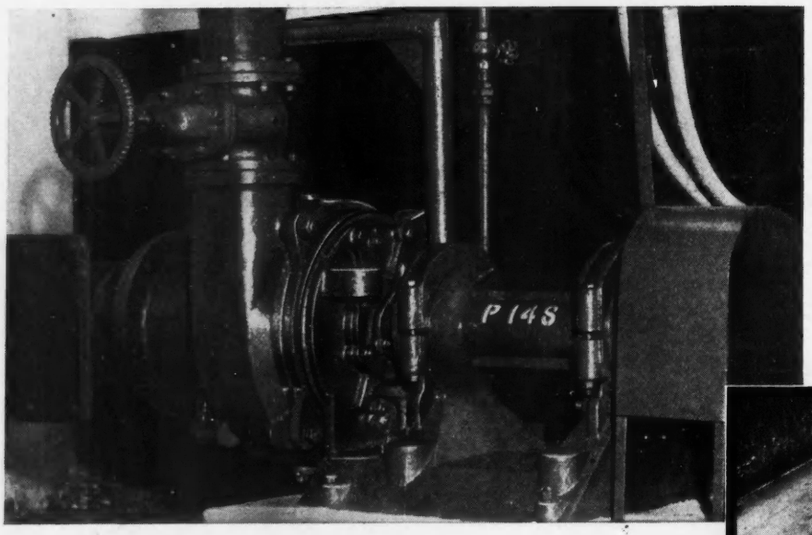

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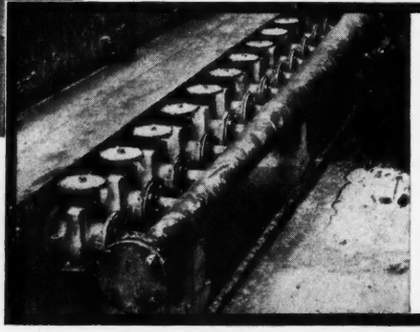

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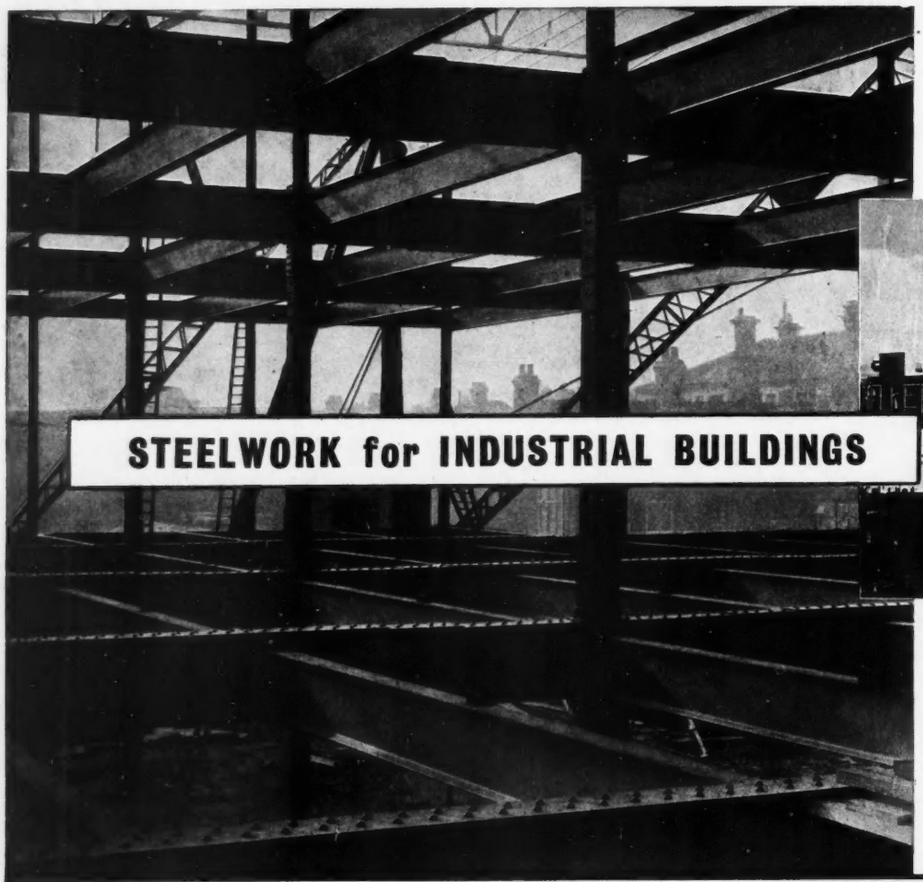

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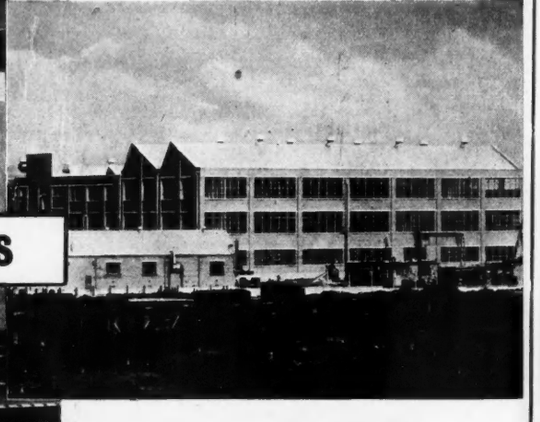

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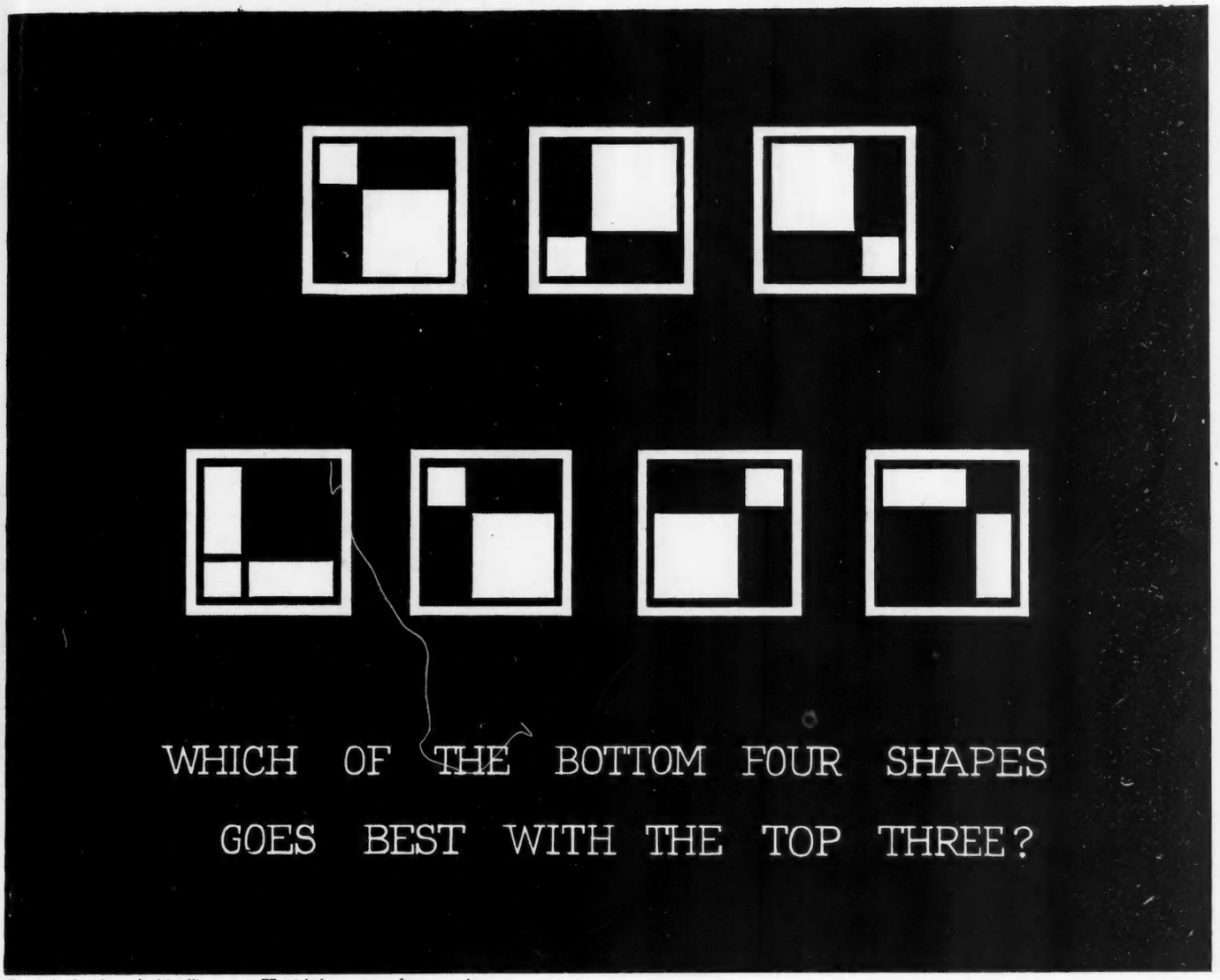

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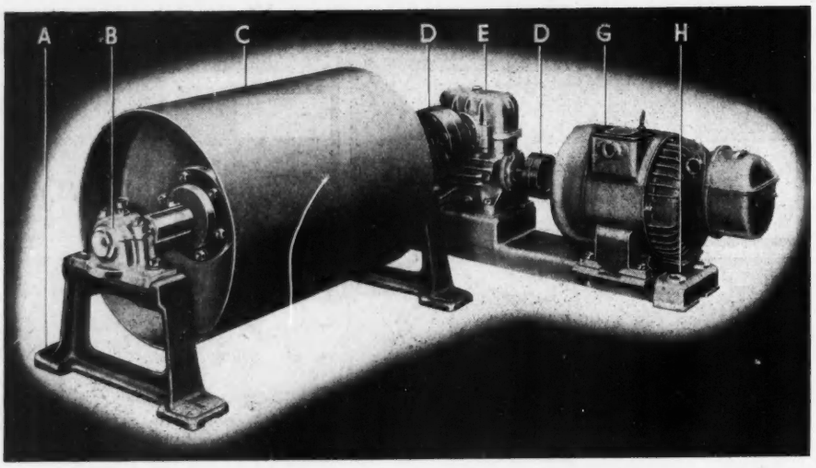

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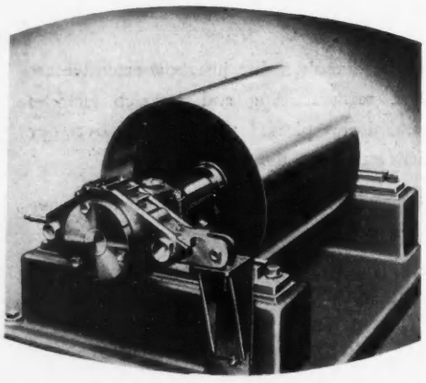

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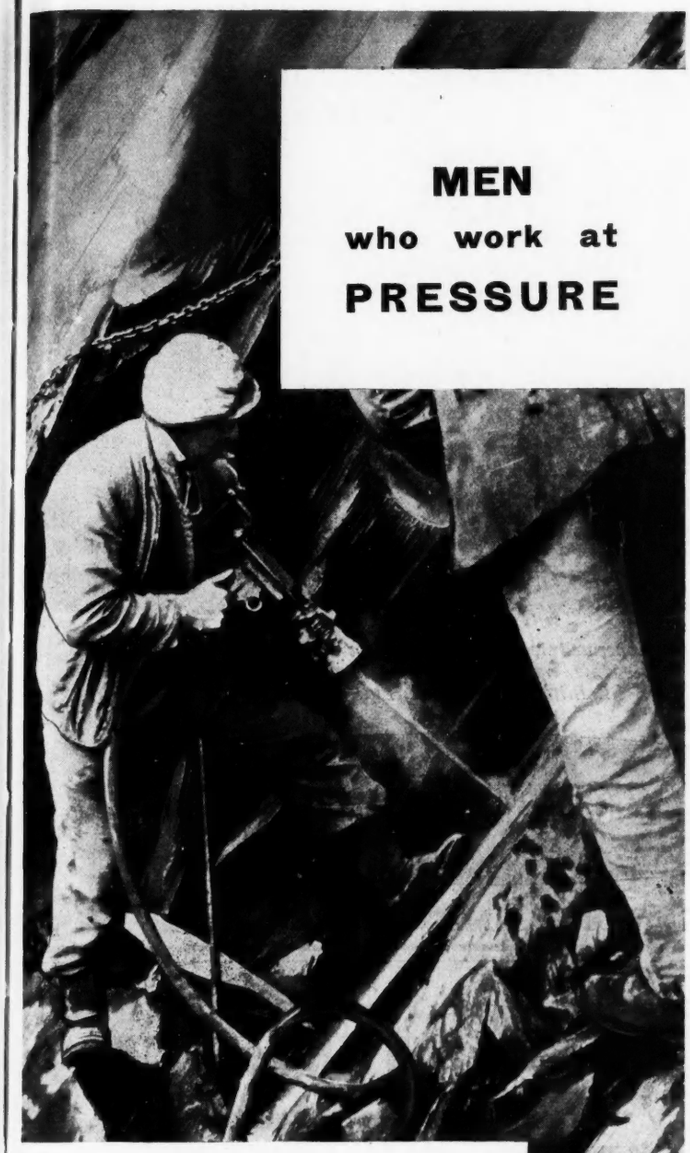

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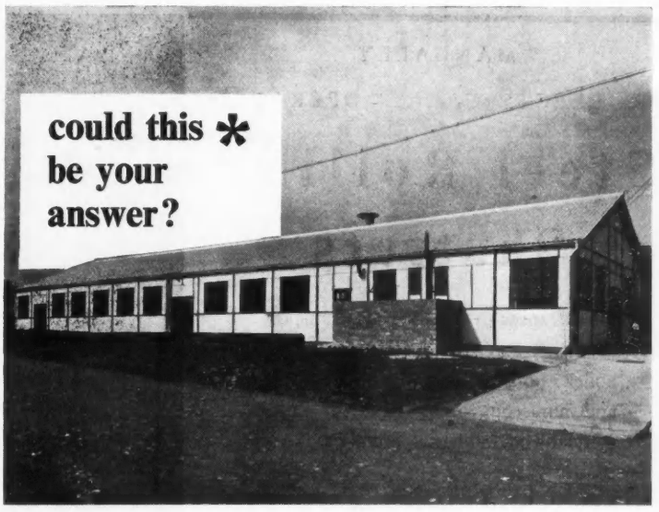

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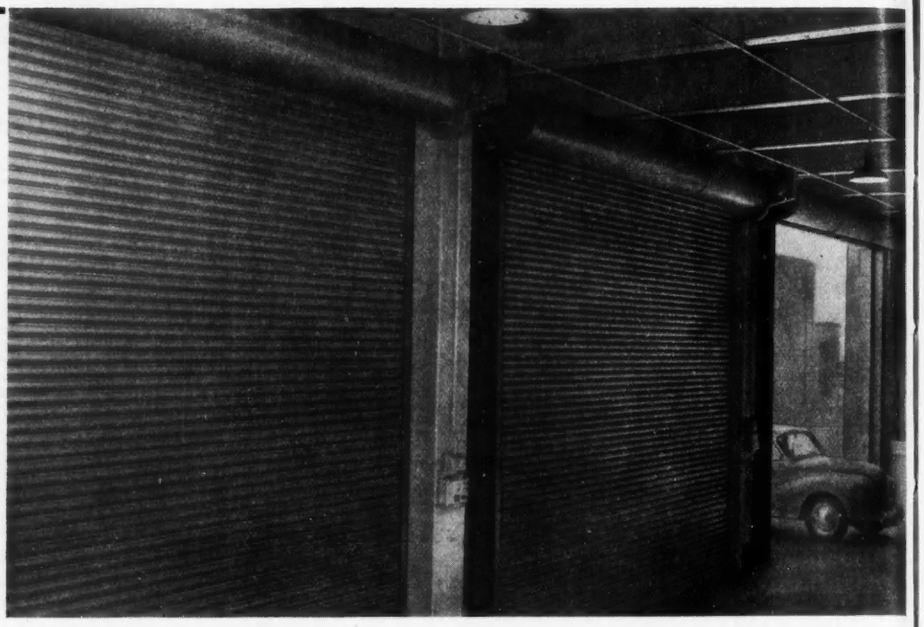

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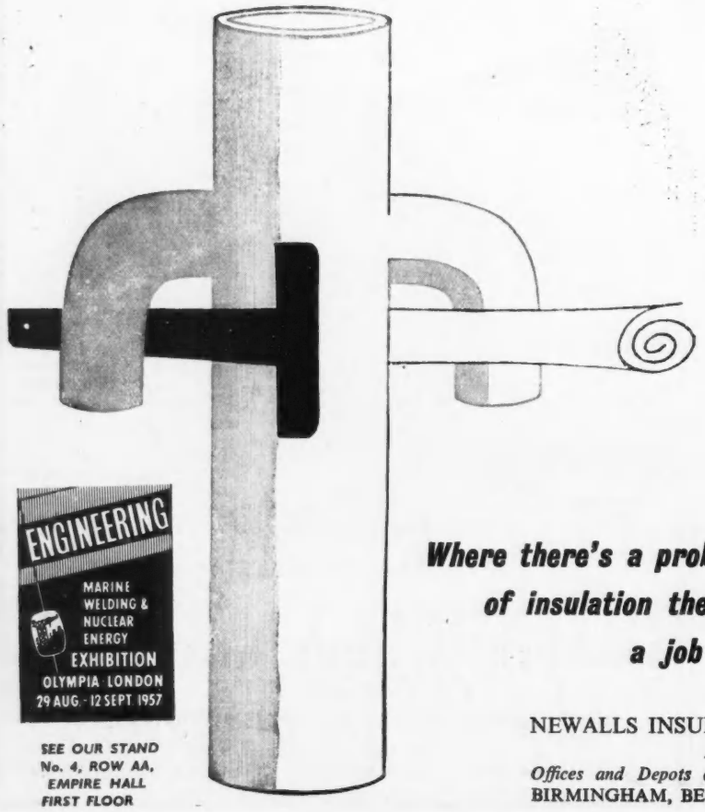

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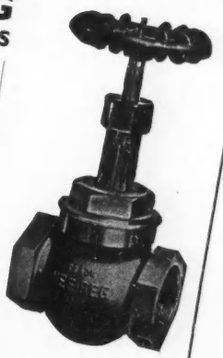

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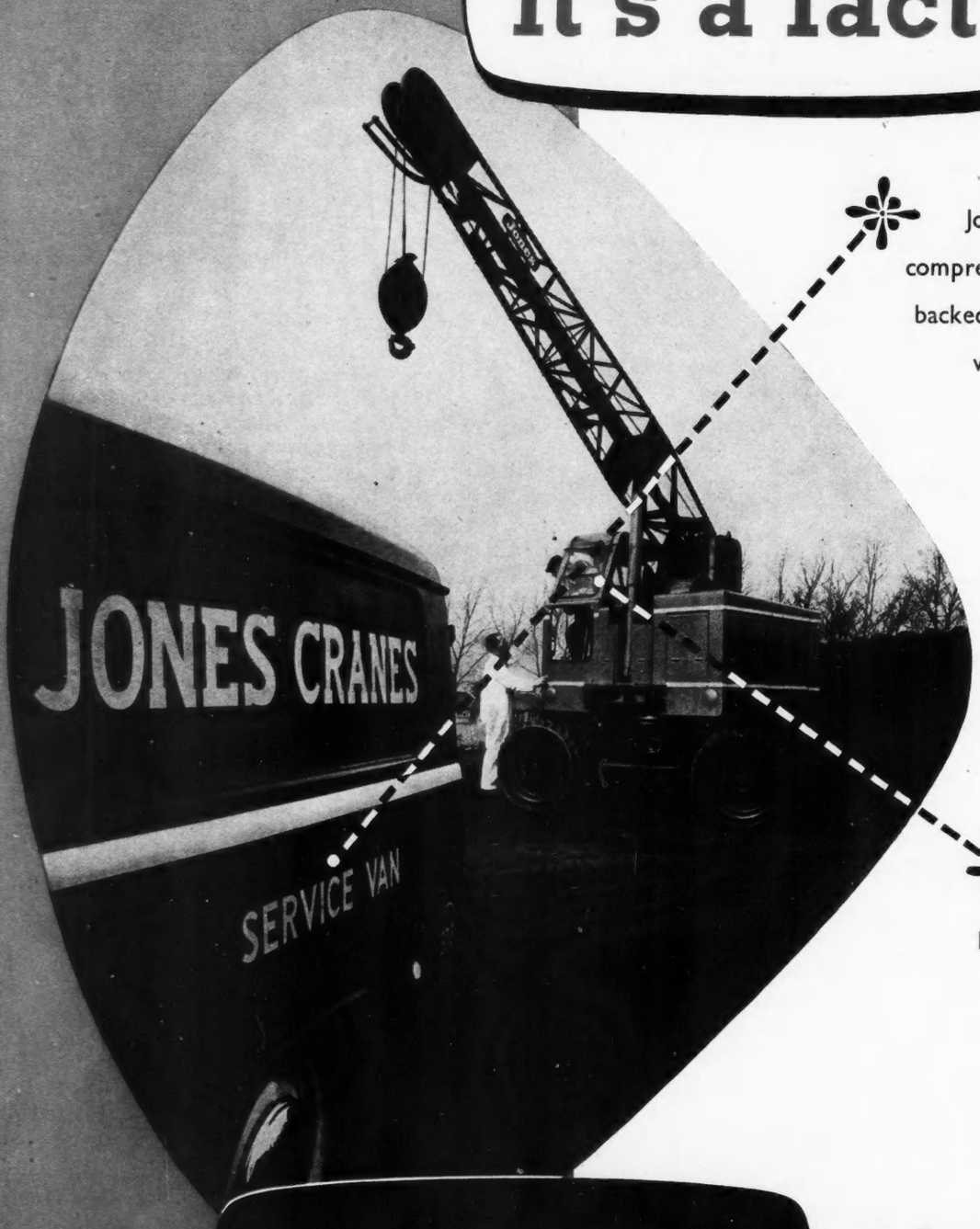

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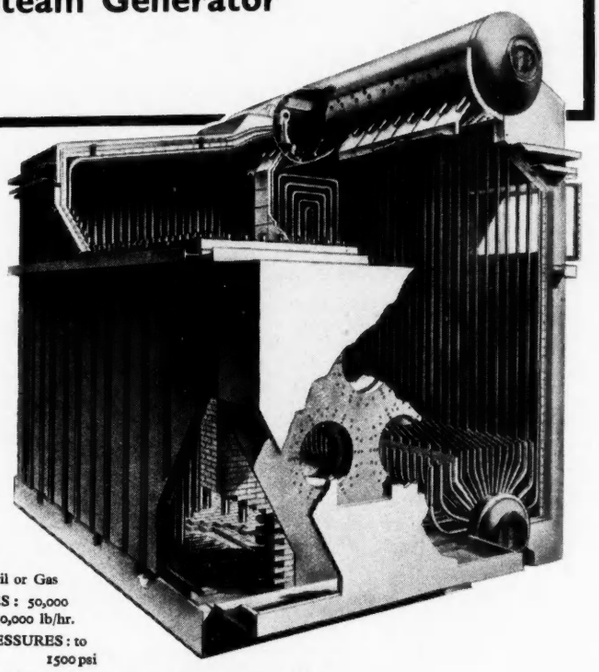

FUELS : Oil or Gas
CAPACITIES : 50,000 to 150,000 lb/hr.
STEAM PRESSURES : to 1500 psi
STEAM TEMPERATURES : Superheat temperatures to 950°F.

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in first cost, installation, operation, maintenance

Series "SC" Steam Generator is pre-engineered, standardized design, with all exterior and structural details fixed. Available in nine sizes, with capacities of 50,000 to 150,000 lb. steam per hr. it incorporates advanced design features that make possible important savings in industrial steam costs.

Burners, controls, upper drum mountings and other equipment requiring attention are located at the front of the unit. Heat recovery equipment and fans can be placed near the operating aisle for either single or multi-unit installations, providing unusual accessibility and ease of operation.

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- *Over 19-foot firing depth.*
- *Unrestricted circulation.*
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- *Efficient convection surface.*
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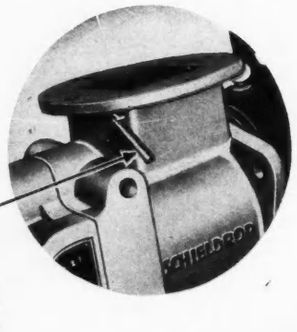

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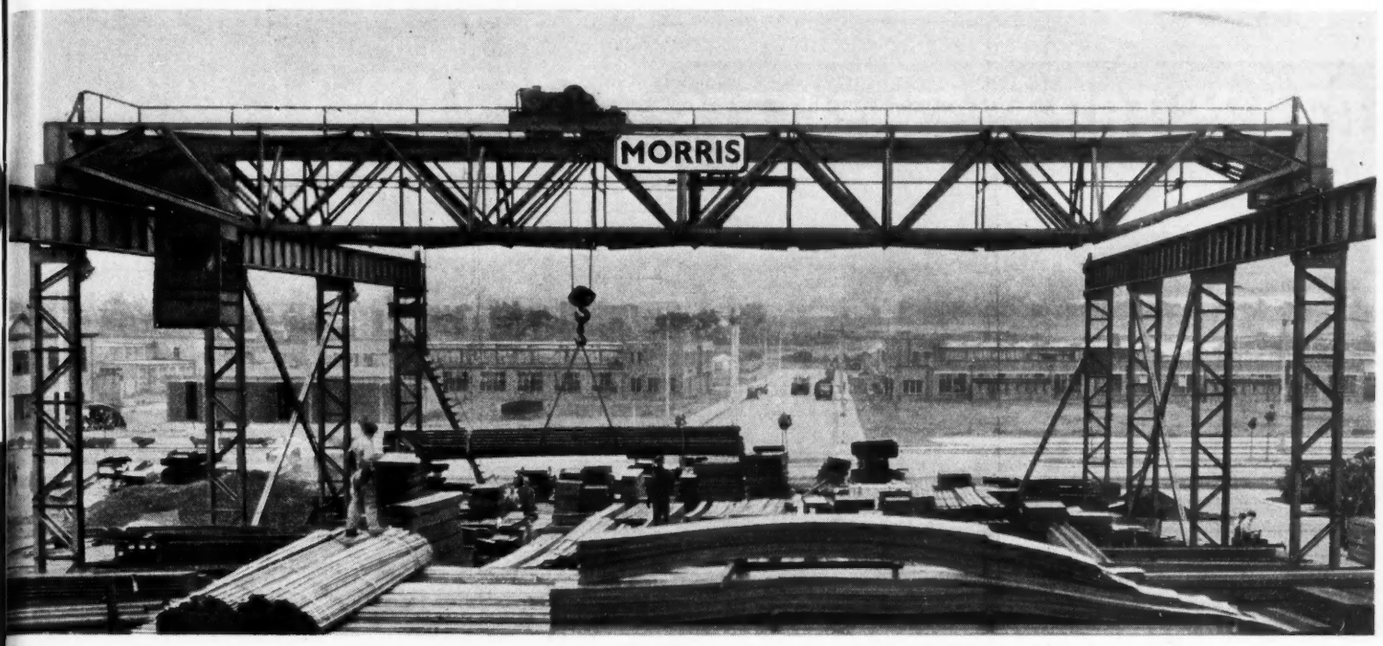

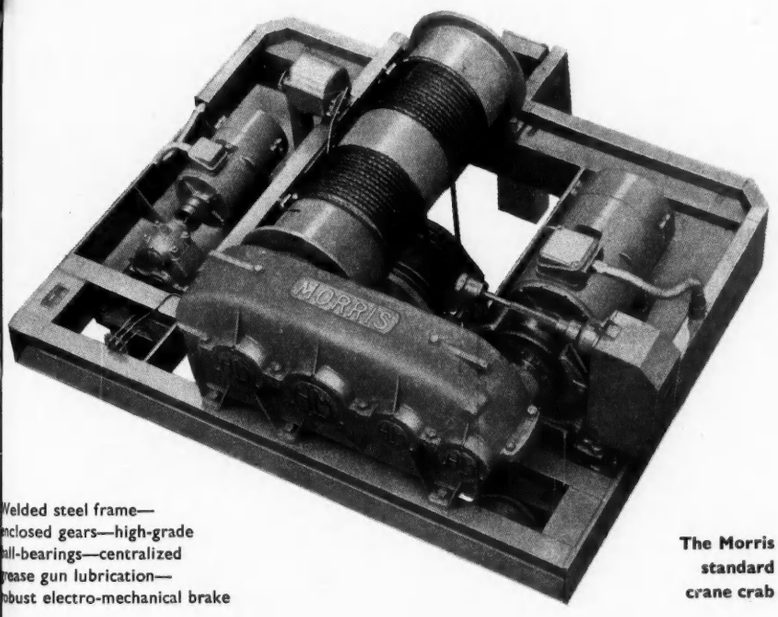

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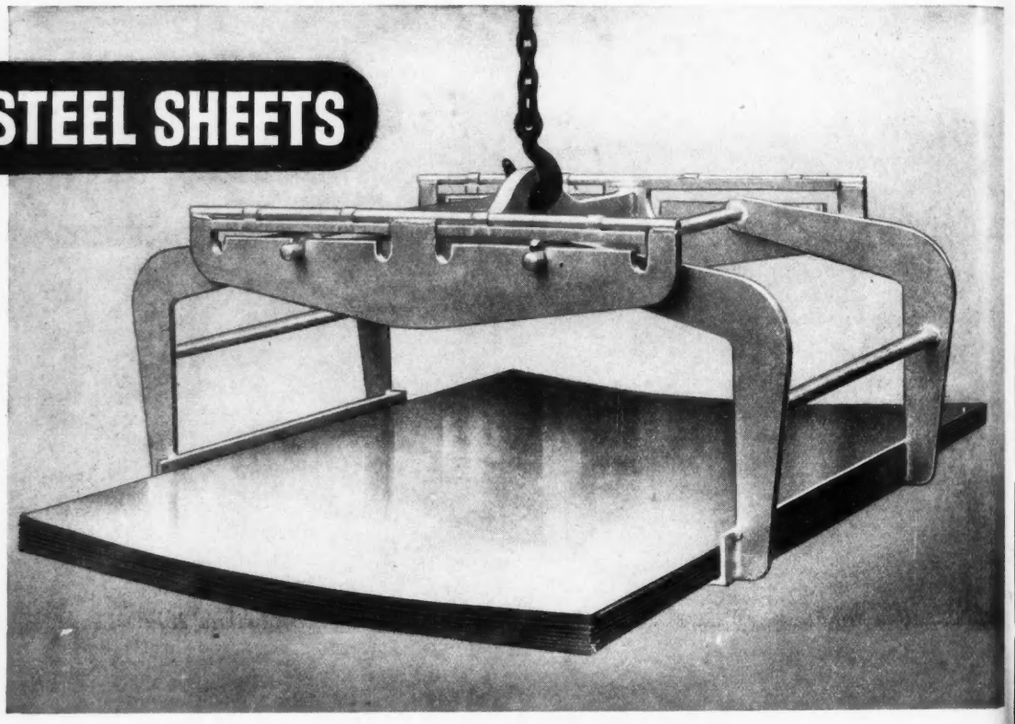

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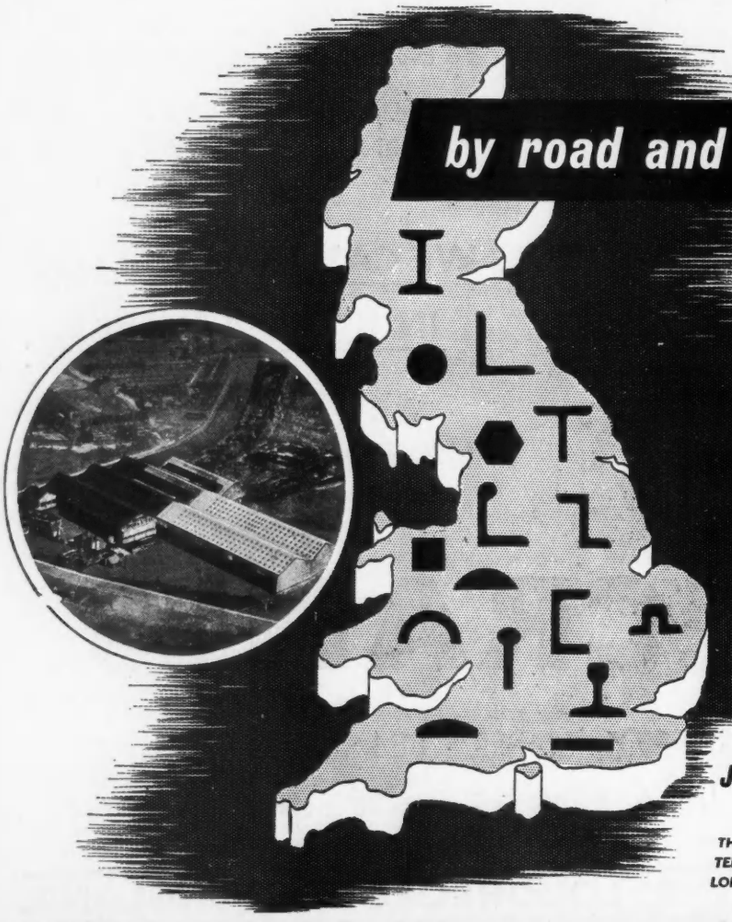

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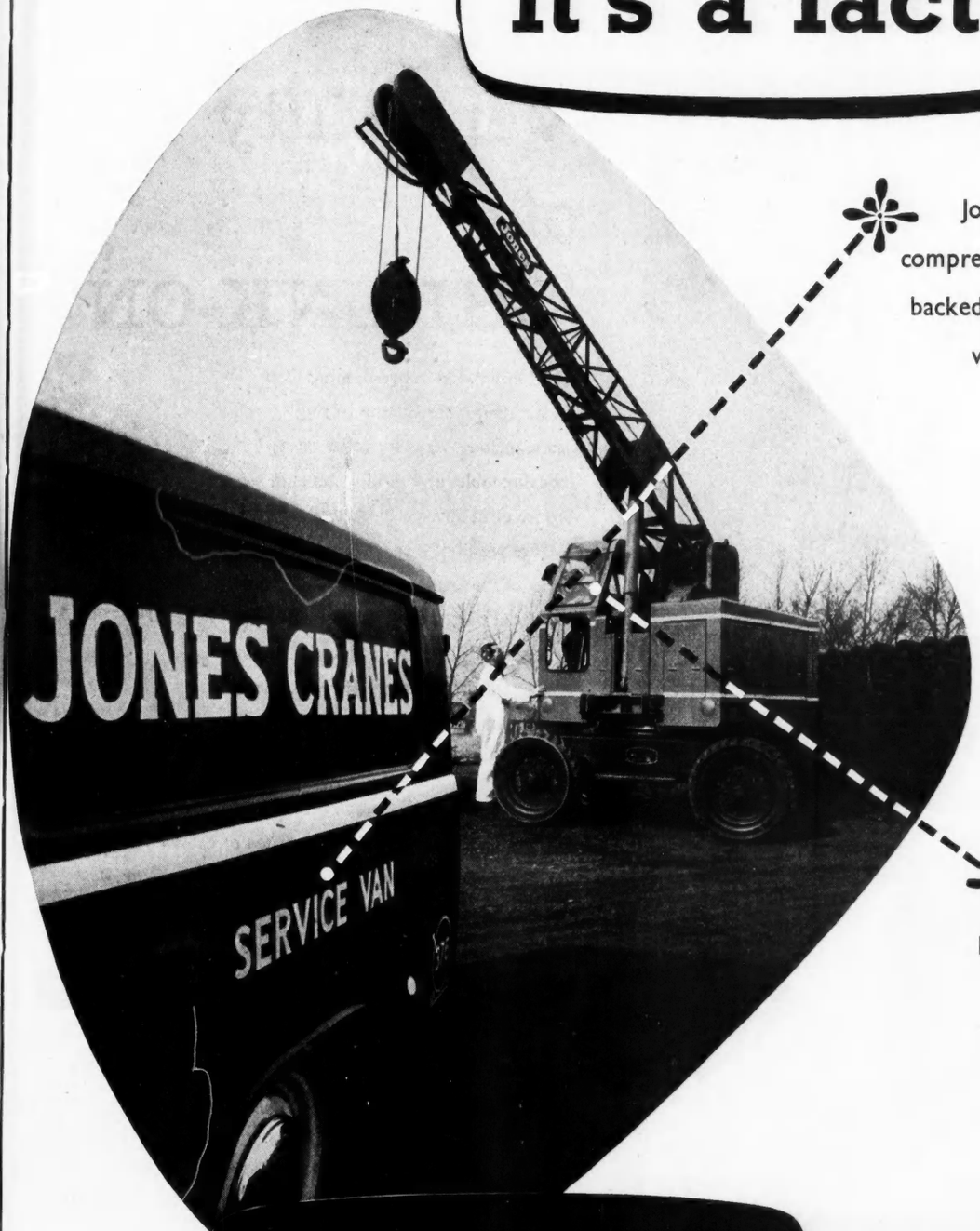

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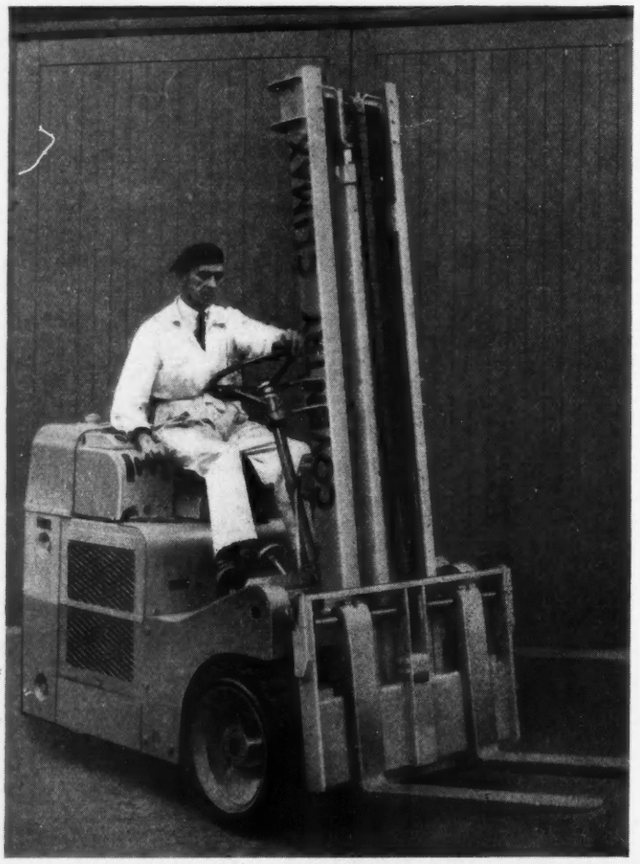

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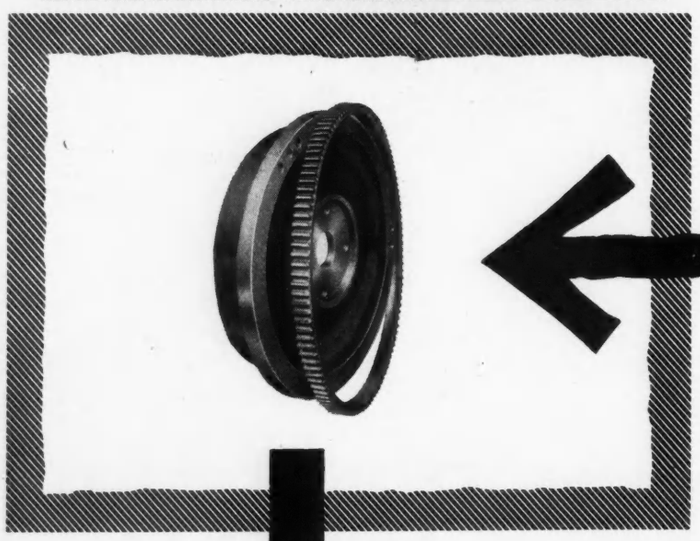
We illustrate a Coventry Climax F.D.C. Type Diesel engined Fork Truck by kind permission of Coventry Climax Engines Ltd., who use the 'Shrunk-On' Starter Ring Gear extensively.



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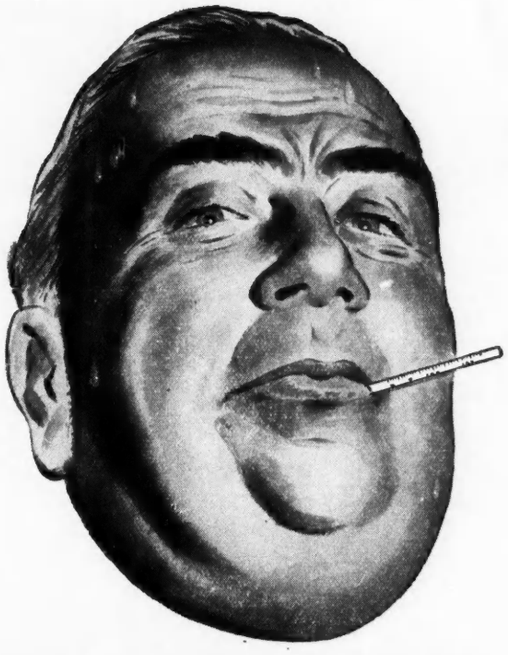

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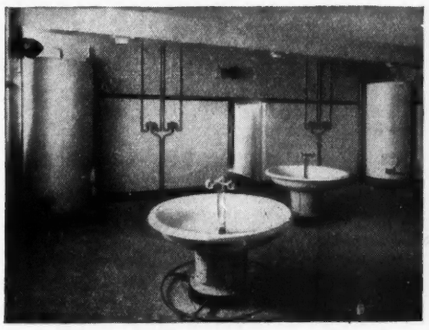

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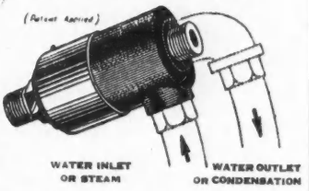

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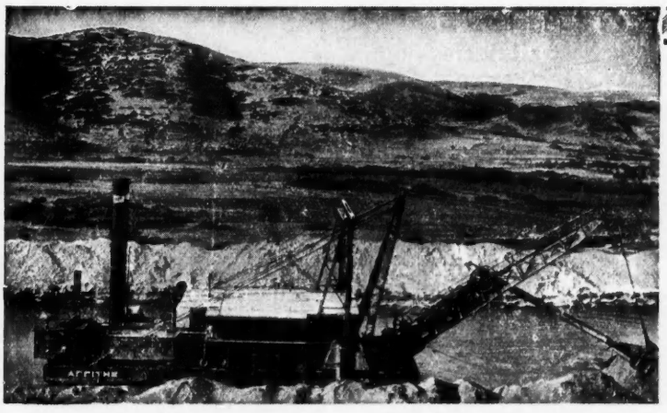

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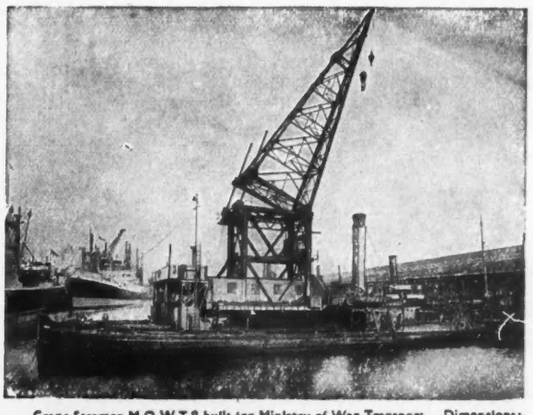

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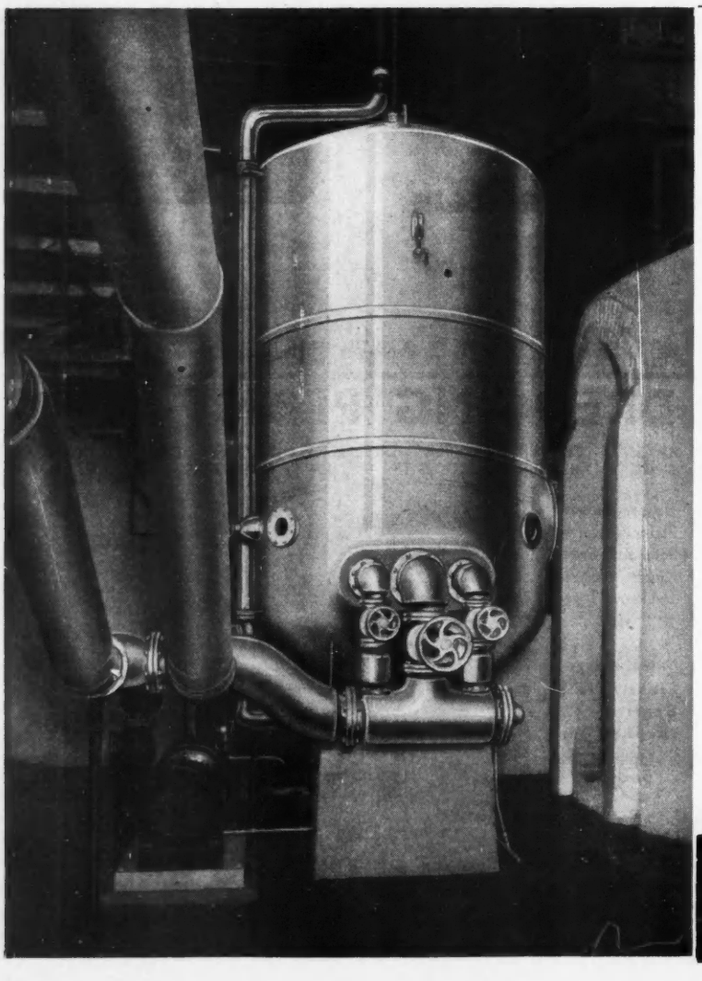

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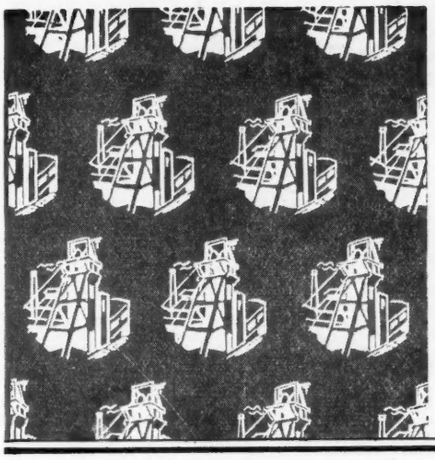

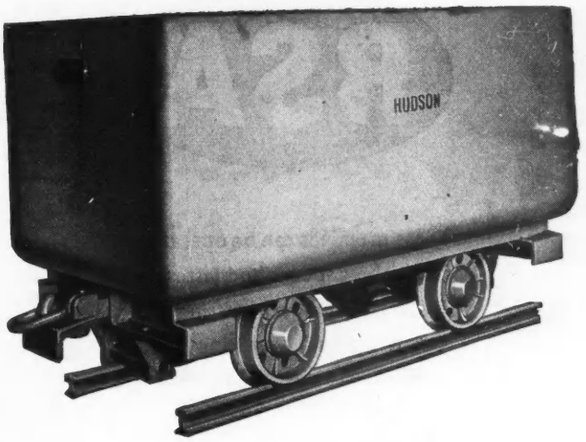

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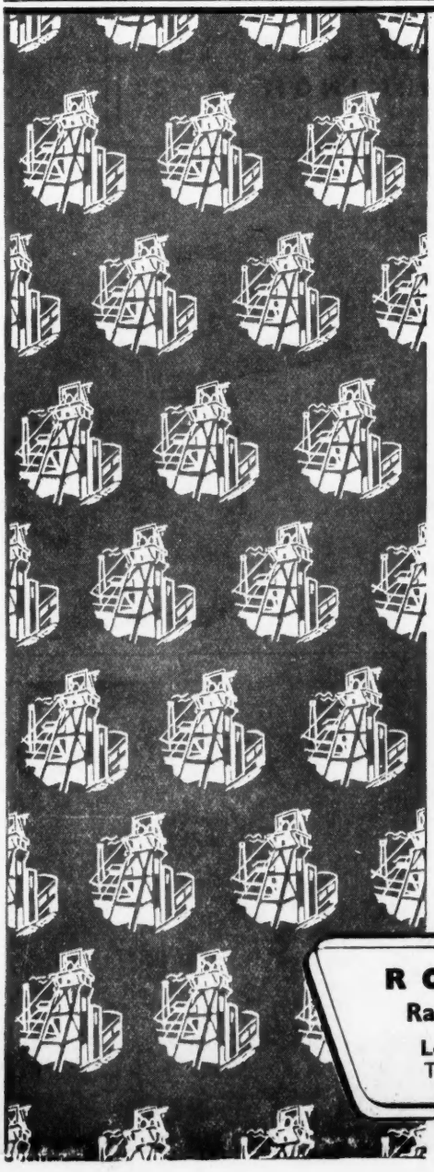
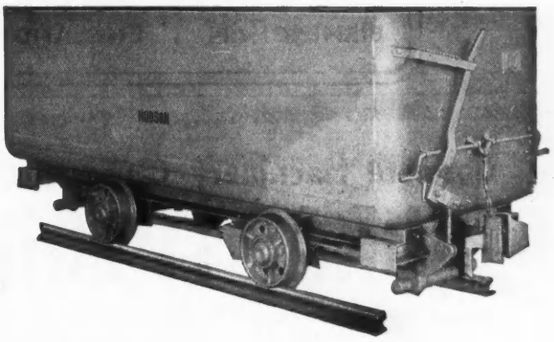
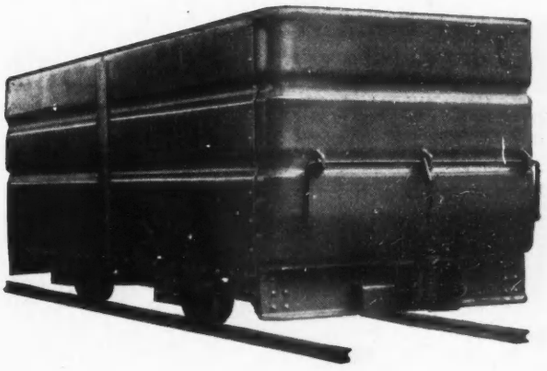




3 ton capacity mine car, to N.C.B. standard design. Hudsons build in all sizes for all rail gauges.



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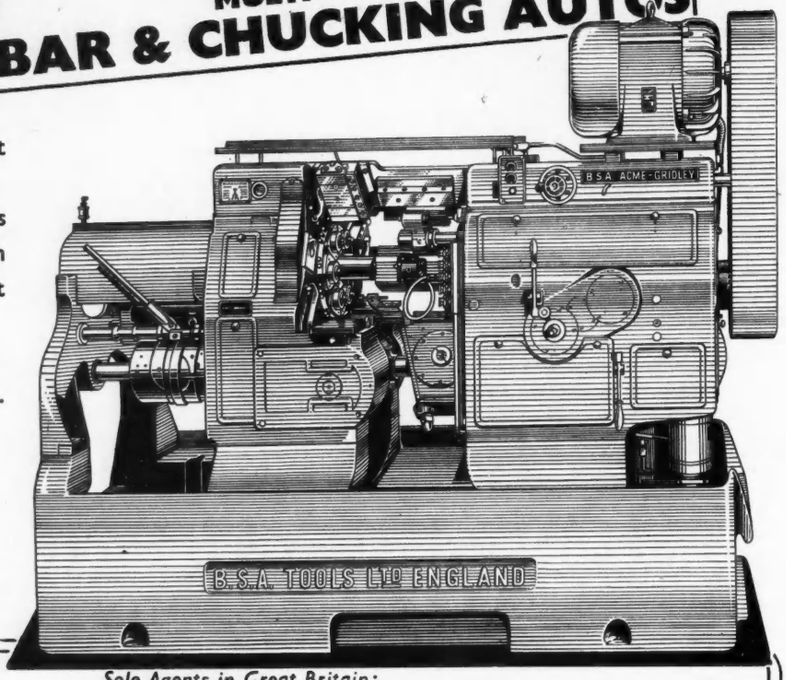

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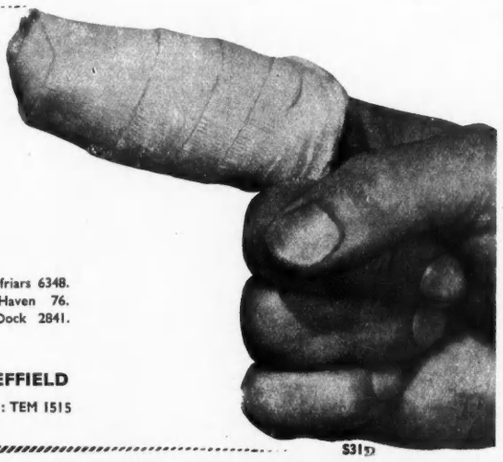

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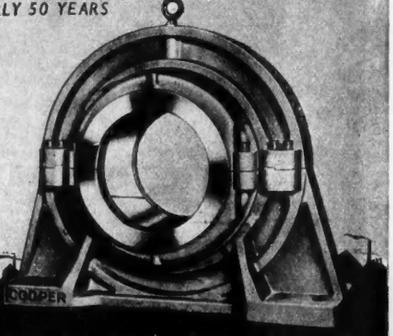

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THE ENGINEER

VOL. 204 No. 5297 AUGUST 2, 1957

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ATOMIC ENERGY REPORT

The third annual report of the United Kingdom Atomic Energy Authority, which was published last week, has received less public attention than it deserves. As an item of news, it was overshadowed by stories about strikes, yet it is a report that deserves close study. The year 1956–57 was a milestone year for the Authority—and, for that matter, for the country—as it was during that period that the first reactor at Calder Hall came into operation. Yet, great though that achievement was, the activities of the Authority are now so widespread that comment on it only occupies a small portion of the report. Reading through the Report, one gets an impression of consolidation, both technically and administratively. The Authority is now firmly established ; the severance from the Ministry of Supply has been completed. Commercial accounting is now reported to be in operation in all groups of the Authority, and the transitional problems associated with the change over from government department to statutory authority have largely been overcome. In this same year, the arrangements for the return to appropriate government departments of civil servants who decided not to join the Authority's staff were also completed, and in future recruitment will no longer have to take into account the need to make good such losses.

While this domestic reorganisation was being completed the Authority has had to face major readjustments to give support to the implementation of the nuclear power programme and also the ever-expanding activities in the international sphere. With regard to the former the report points out that the Authority now has a fourfold interest in the nuclear stations being built for the electricity authorities. In the first place the Authority is involved in the development of suitable fuel elements. Secondly, the Authority is acting as technical adviser to the electricity authorities for the nuclear side of the new power stations. Thirdly, the Authority is responsible for procurement of adequate supplies of special materials, such as uranium and graphite ; and fourthly, it will process the uranium concentrate and fabricate it into fuel elements for sale to the electricity authorities. The first of these commitments will demand considerable research and development effort, and a continuing programme of irradiation work in the new research reactors at Harwell and Dounreay. To meet the second responsibility the Authority has found it necessary to set up a completely separate organisation within the Industrial Group. The production of fuel elements and the subsequent chemical processing of irradiated fuels will obviously become an ever-growing business for the Authority. The report also points out that the rapid increase in, and expansion of, atomic energy plants has necessitated a continuing review of safety policy in order to ensure that the record that the Authority has built up is maintained. During the year the Authority has felt it necessary to reorganise its structure of safety committees, and it has established a permanent Safety Branch to serve the new committee structure. A large measure of responsibility for the radiological protection of the new power stations has also been accepted by the Authority. The year has also brought to the fore the whole question of where reactors should be sited. Because of the importance attached to this subject, and bearing in mind the fact that reactor systems other than the Calder Hall type are under consideration for use in this country, the Authority has embarked on experimental work to increase its knowledge of the conditions which might arise in the event of reactor failure. The training of scientists and engineers from British industry and from overseas countries has continued on an increasing scale. Overseas interest in the work of the Authority has now become so great that some limitation has had to be placed on visits to the Authority's establishments. It has also been impossible to meet all the requests from overseas countries for lectures from

British scientists and engineers, because the people concerned cannot always be spared from their normal work.

Important and extensive as these activities are, they do not by any means cover the whole purpose of the Atomic Energy Authority's existence. Though the immediate nuclear power programme may demand considerable support from the Authority, it must not be obtained at the expense of the leadership that is required as to where we go in the future. The reactor systems and reactor experiments that the Authority considers to be worth working on now will settle the pattern for the power programme for many years to come. New applications for reactors, such as for marine propulsion, are equally important. Not everything that engineers would like to see done, can possibly be done immediately ; but, as we have stressed several times before, the future of atomic energy in this country is very much dependent on the skill with which the objectives are selected and on which our limited resources are deployed. In this connection it is interesting to read in the report that the conception of three successive stages in the country's nuclear power programme has already been abandoned as being too inflexible. The development potentialities of the gas-cooled graphite-moderated reactor have, in fact, made it much more difficult to justify the inclusion of what were previously referred to as the Stage 2 reactors. As a result effort must be devoted more and more to developing reactors which are likely to have lower initial capital costs. The fast breeder reactor is expected to start operation during 1958 and high priority is now being given to a high-temperature gas-cooled reactor to work eventually on a thorium cycle. The application of nuclear power to ship propulsion has been receiving considerable attention, and obviously the Authority would like to develop power units of 30MW or less for the export market. Looking much further to the future, research into ways of obtaining power from controlled thermo-nuclear or fusion reaction is being actively pursued at Harwell. All these factors, supported by intensive programmes of fundamental research, indicate a healthy and vigorous state in the field of atomic energy. Additionally, no doubt, the Authority has recently had to confer with the Government about its relations with "Euratom," the international organisation likely to come into being on the Continent. How closely ought research and development here to be linked with that being done on the Continent ? That the Atomic Energy Authority has been able to accomplish so much in the way of reorganisation, consolidation and expansion during the period covered by this report, without losing the impetus to press forward as rapidly as possible, is an achievement that deserves recognition.

STEEL DEVELOPMENT

When the Iron and Steel Board was set up under the Iron and Steel Act, 1953, its principal duty was defined as exercising "a general supervision over the iron and steel industry with a view to promoting the efficient, economic and adequate supply of iron and steel products under competitive conditions." One of the ways in which the Board carries out this task is by keeping the industry's productive capacity under review. Just over two years ago, the Board produced a report describing the steps that were being taken to meet steel requirements in the five-year period 1953–58. The proposals outlined in that report, and some amendments subsequently made, were designed to bring British steel making capacity to about 23,500,000 tons by the end of 1958. Most of the schemes listed in that report are now well on the way to completion, and it is therefore essential that the Board should have considered the further development of the country's iron and steel industry.

The Board's second development report, which has been presented to the Minister of Power, was published last week ; its main contents were summarised on page 135 of our last issue. Last year, the Board made as detailed an examination as possible of the probable level of demand for steel by 1962. Since the survey was completed it has been necessary to take into account the effect of recent national and international events, and it has been estimated that, by 1962, the annual home demand for steel will be about 24,000,000 tons. Direct exports by that time are put at 5,000,000 tons a year. The report thus envisages an annual requirement of 29,000,000 ingot tons. But, of course, the level of steel demand and the extent of the employment of the national resources to meet it cannot be divorced from the growth and balance of the economy as a whole. Accordingly, the Board has based its estimate of home steel consumption on the anticipated long-term trend of industrial production in this country. It has assumed that industrial production will increase in the next five years rather more rapidly than the average of 3¾ per cent in the last five years. Quite rightly, on that assumption, it has been thought desirable to aim at some margin of capacity in excess of these estimated requirements, and the Board considers that the industry should provide by 1962 productive capacity for 29,000,000 tons. Allowing for the quantity of re-usable steel available for re-processing and for the normal import of particular steels, it is believed that an annual supply of 30,000,000 tons would be forthcoming. Development proposals which have been put forward by various companies and which have already been approved by the Board can bring the productive capacity for crude steel up to 28,000,000 tons by 1962. Other proposals, still under discussion or moving towards final approval, would raise the figure to 29,000,000 tons. Yet, given adequate capacity, an annual production of 29,000,000 tons of crude steel cannot be achieved unless the raw material supplies are assured. Naturally, this has been an important factor in the Board's survey. In the first place, there is increasing competition from other steel producing countries for overseas ore, and this country is having to look further afield for its supplies, a matter which inevitably raises the problem of the most economic ore carriers. The report emphasises, however, the prospects for increasing the output of home-mined ore to about 22,000,000 tons a year by 1962. Then, consideration has to be given to semi-finished material. Billet production will increase, the report says, but "further modern capacity is needed." Nevertheless, as a result of its investigations, and in the light of the development proposals described in its report, the Board believes that "in most cases" supplies of finished steel should be adequate, though there is obviously a little doubt about sheet and tinplate. The Board takes the view that there is need for a new continuous strip mill to be operating by 1962, but, at present, the industry does not fully support that view ; the industry believes that the need will not arise until later. No decision has yet been taken, and the problem is still being discussed with all the interests concerned.

This, then, is the essence of the Iron and Steel Board's second report on development. Actually, it represents the industry's third programme of expansion in the post-war years, for the first, it will be recalled, was prepared by the British Iron and Steel Federation in 1945, and its proposals were given effect in the six years 1946–52, despite the upheaval caused by the temporary nationalisation of the industry. Between 1946 and the end of last year, the steel companies expended about £710 million on their re-equipment and expansion programmes, and the proposals now detailed will involve another £600 million. In discharging its responsibilities, the Iron and Steel Board is required to consider whether the scale and pace of development are adequate. But it must not be overlooked that the financial responsibility for development rests with individual producers who in the end, as the report acknowledges, must plan and carry out the projects. The iron and steel producers, in common with the rest of industry, have to face increasing costs. The recently announced price rises for iron and steel are not likely to receive a cordial welcome, but they may prove to be not altogether unreasonable when it is remembered that a continually expanding steel industry is imperative in an expanding economy.

A Seven Day Journal

Institution of Mining Engineers

THE summer meeting of the Institution of Mining Engineers, held in Newcastle upon Tyne last week, opened with a general session on Wednesday, July 24, at which two papers were presented. The first of these papers, "Colliery Reconstruction in North Staffordshire," by Mr. R. W. Scurfield, is reproduced in an abridged form on page 162. The second paper, "Off Shore Boring," by Mr. F. Marsh, reviewed the geology of the Firth of Forth coalfield and the North-East coalfield in England, and the need to prove further areas of undersea coal by off-shore boring. It described the construction and operation of the sea boring tower specially built for this work, and gave some details of the operations involved in the boreholes already made and those contemplated in connection with these investigations.

Lord Mills, the Minister of Power, was one of the speakers at the dinner of the Institution on Wednesday evening. He said that the rebuilding of the coal mining industry in this country required a considerable capital expenditure if coal output was to be maintained and then expanded. The nuclear power programme would in no way diminish the demand for an increase in coal output, for if the country's requirements were to be met there would have to be a threefold increase in power supplies in about ten years. Sir James Bowman, chairman of the N.C.B., said that mining engineers should have for their target a fully satisfied home market and a healthy export market in coal. The present coal output figures indicated that the capital expenditure in the coal mining industry to date had been justified; but, said Sir James, much remained to be done, and in this work the mining engineer had an important part. The president of the Institution, Mr. E. H. Browne, in proposing the health of the guests, said that, despite the glamour of the projected nuclear power age, the coal industry was still and would long remain the key industry, and the foundations of its future prosperity were now being laid by the mining engineer. During the course of the meeting members visited a number of collieries and works, including those of Victor Products (Wallsend), Ltd., and Hugh Wood and Co., Ltd., where they were given an opportunity to see the modern production methods and equipment now used in manufacturing mining plant.

European Organisation for Nuclear Research

THE second annual report of the European Organisation for Nuclear Research (CERN) has been issued. It contains accounts of the CERN Symposium in 1956, research work carried out under the authority of the Director-General, progress with the proton synchrotron and the synchro-cyclotron, and various other activities. As the introduction states, however, several years of work will be needed before "Europe's great joint laboratory for advanced nuclear research" comes into full operation.

During 1956 much attention was concentrated on getting the construction of the proton synchrotron under way (THE ENGINEER, August 17, 1956). The basic parameters were not changed. Specifications were finalised, tenders invited, various contracts negotiated, and manufacture of some of the equipment begun under CERN supervision. The machine buildings, laboratories and offices were nearly completed.

Consideration was given to the preparation of a programme of experiments for the synchro-cyclotron. The CERN Symposium showed that a fair number of the experiments for which the machine was built had already been done, and it was decided to concentrate on the highly accurate work.

Effort was devoted to the development and initiation of special techniques for use with the accelerators. Matters studied included cryogenics (mainly connected with bubble chambers), evaluation of experimental data, and protection against radiation. It was decided to build an initial plant to produce liquid hydrogen. The use of certain fluids, such as liquid hydrogen and liquid helium, is regarded as still being hazardous, but the new techniques are hoped to make it normal practice throughout the laboratory.

The sixth session of the Council approved a policy of restraint in patenting activity on the ground that CERN was intended to carry out fundamental research unconnected with commercial application. Inventions were to be made free to the world by early and complete publication. The final accounts for the financial year 1956 show an expenditure of Sw. Fr. 38,792,472·94 and receipts of Sw. Fr. 39,598,795·27.

The Engineer
100 Years Ago

(JULY 31, 1857)

"STEAM CULTURE"

"Is the prize of FIVE HUNDRED POUNDS offered by the Royal Agricultural Society, '*For the steam cultivator that shall, in the most efficient manner, turn over the soil, and be an economical substitute for the plough or the spade*,' won? Is Mr. Hall, Mr. Fowler, Mr. Boydell, or Mr. Williams entitled to the prize? Such is the question which now engrosses the attention of all who are taking an interest in the important subject of steam culture, as lately exemplified at Salisbury. The majority, we believe, express themselves disappointed. We do ourselves; but what does that signify? . . . Of course, the issue will not be known until the August meeting of the council, if it is even then settled.

"We cannot entrust a question of so much importance *exclusively* to the council of the Royal Agricultural Society, and therefore we unhesitatingly repeat that the prize is fairly won. True it is, 'an economical substitute for the plough' is rather a paradoxical proposition—one having more relation to the rotary effusions of 'Zalpa' in his 'Chronicles of a Clay Farm' than to the motto of the society 'Practice with Science;' for how can a plough be a substitute for a plough? The Society, having fallen into this mistake last year, cannot be allowed the privilege of doing so again, for the purpose of pocketing its £500. A practical meaning must now be put upon the offer, which is obviously to this effect, 'An economical steam plough as a substitute for a horse plough;' or 'an economical steam digging machine for the common spade.' And with such an interpretation we have no hesitation in saying that the Society will be unable to justify itself if it withholds the prize, for the solution of the problem before us is more a matter of principle than practical detail; the grand desideratum being a substitute for the horse rather than a substitute for the plough—for the most efficient and economical manner of yoking steam to the plough rather than for the best ploughed land."

Higher National Diploma in Production Engineering

THE Ministry of Education has announced a scheme for full-time courses leading to the award of a Higher National Diploma in Production Engineering. It has been arranged by the Ministry in conjunction with the Institution of Mechanical Engineers and the Institution of Production Engineers. Arrangements for part-time courses leading to the award of Higher National Certificates in Production Engineering have existed since 1941. Local education authorities and technical colleges have now been informed of the rules and conditions governing the award of the new diploma. A full-time diploma course must extend over at least three years and must, as a rule, be taken at one college. It must also be suitable for students who have had full-time education normally up to the age of eighteen and who, before starting the third year of the course, have had at least one year's regular employment in the engineering industry.

American Grant for Aslib Research

THE U.S. National Science Foundation has awarded £10,000 to Aslib for research on indexing systems. The two-year programme is to be conducted at the College of Aeronautics, Cranfield, under the control of the librarian, Mr. C. W. Cleverdon. It is hoped to find criteria for the choice of one or another indexing system in given circumstances. About 20,000 research reports on aeronautical engineering matters are to be indexed using five different systems, and exhaustive tests are then to be carried out to compare the efficiencies of the systems under varying conditions.

The research follows recognition of the problems that have arisen since before the last war. The rate at which papers are issued, and the number of workers involved in each field, has increased greatly. Individuals can no longer keep abreast of developments over more than a very narrow band in the spectrum of activity, and even the specialist is often confined to a cursory glance at potentially valuable papers. Unnecessary duplication of work has been one of the evils resulting from this *embarras de richesse*.

Improvements in North-Eastern Waterways

IMPROVEMENTS costing £1,500,000 are to be made in the Aire and Calder Navigation and in the Sheffield and South Yorkshire Navigation waterways. Over 2,500,000 tons a year are at present carried on the former and nearly 1,000,000 tons (mostly coal) on the latter. The improvements to be made include bank protection and navigation works, mechanisation of locks, and modernisation of dredging plant. New workshops are to be erected at Goole Repair Yard, the chief boat repair centre for the northern area of British Transport Waterways' N.E. Division. There will also be some new machinery for the Stanley Ferry Repair Yard, near Wakefield.

The programme is designed to increase the traffic carrying capacity on the routes linking the West Riding of Yorkshire, Sheffield, Rotherham and Doncaster, with the ports on the Humber. The work is to form part of the British Transport Commission's development plan for its principal inland waterways. The execution of the plan is to cost £5,500,000.

The Big Hill, Canadian Pacific Railway

By EDWARD H. LIVESAY

No. I

A MAP of Western Canada (Fig. 1) shows the main lines of two transcontinental railways converging on the city of Winnipeg from the east, and crossing each other there; on leaving, almost at once they begin diverging, getting farther and farther apart in traversing the 1000-mile wide prairie Provinces, the great Canadian granary, until finally they reach the Rocky Mountains, the western rampart of British Columbia. Through this massive barrier they find tortuous paths by two passes, the Kicking Horse and the Yellowhead, 200 miles apart, the C.P.R. utilising the former and the C.N.R. the latter, continuing thence to the Pacific, a further 500 miles or so to the west, reaching tidewater at two points, Vancouver and Prince Rupert. Amplifying, it was the former Grand Trunk Pacific that had its terminus at Prince Rupert, and the Canadian Northern that, after threading the Rockies, swung south-west to Vancouver ; both came through the Yellowhead, and were afterwards amalgamated, to form the existing Government-owned Canadian National Railway. This is the state of things to-day, and has been for upwards of fifty years, but in the eighties of the last century, when first the great conception of a transcontinental railway took concrete shape, it was the C.P.R. alone that was under consideration and construction. Any route across the prairie and through the mountains could have been chosen, at the discretion of the promoters and the Government backing them ; it was merely a matter of deciding which would be likely to bring the quickest returns, and where it should be located. The possibilities were many, the choice almost as free and wide as the country to be traversed, but a final analysis narrowed the most promising surveys down to two, leading respectively to and through the Kicking Horse and Yellowhead Passes in the Rockies. Westward from Winnipeg as far as Moose Jaw there was no dispute, but at this point a decision had to be made whether to continue straight on to Calgary, follow the Bow River upwards to the Gap, and on to where Banff and Stephen are now situated, descending the western side of the mountains by the Kicking Horse Pass, or, alternatively, take a north-west direction from Moose Jaw through Battleford and Edmonton to the Yellowhead Pass, then swinging south-west along the North Thompson River, before picking up the survey common on both routes at Kamloops, and carrying on through the Fraser Canyon to Vancouver, the focal point on the coast. The latter choice at first sight seemed the best, the line passing through finer agricultural country on the prairie than the former, and threading the Rockies at a much lower altitude, with the natural corollary of easier gradients ; in addition, the passage of the Selkirks, though farther north, was much simpler. The southern Kicking Horse route, on the other hand, involved much heavier going through both Rockies and Selkirks, these two major ranges having to be surmounted just where they impose the greatest obstacles—the farther north, the lower they are, and the wider the valleys through them. Certainly, the northern, Yellowhead route, would have seemed preferable ; moreover, once through the Rockies, it would follow a comparatively trouble-free valley into Kamloops. After this, there remained but one practicable way through the Thompson and Fraser Canyons into Vancouver, and it is this route that Mackenzie and Mann followed when they built their Canadian Northern line to that city thirty years later.

Despite the discovery of this apparently preferable northern survey, and after it had actually been approved by both Government and promoters, the less desirable southern location was actually chosen ; the direction of the line westwards from Moose Jaw was changed, and it was built straight on through Medicine Hat and Calgary, thence upwards to the Gap and the summit at Stephen, and down the western side of the mountains following the turbulent Kicking Horse River and canyon. For some reason or other, at the last moment, this unlikely choice was made, and there has since been much speculation why it happened. It may have been a matter of first cost, which would be considerably less, or it may have been that time would be saved in construction due to the shorter distance between Moose Jaw and Kamloops. But whatever the reason, the price has been paid ever since in high operational expense, and the necessary improvement of the original location, amendments including not only the taming of the Big Hill incline by the construction of the two spiral tunnels, but the boring of the 5-mile Connaught tunnel through the Selkirks to Glacier, to do away with the zig-zag down the western side of the Selkirks *en route* to Revelstoke. Seventy-odd years of costly and hazardous operation through the wilderness of mountain and canyon typical of British Columbia resulted from this alteration of the original plan, and one cannot help wondering why the better route, once definitely adopted, was discarded for an inferior one.

Several reasons have been advanced, some plausible and possibly more or less valid, others less so or demonstrably untenable. "The southern prairie country was agriculturally better"—very questionable, and certainly incorrect with regard to most of the land south of the line from Moose Jaw to beyond Medicine Hat, which is mostly in the

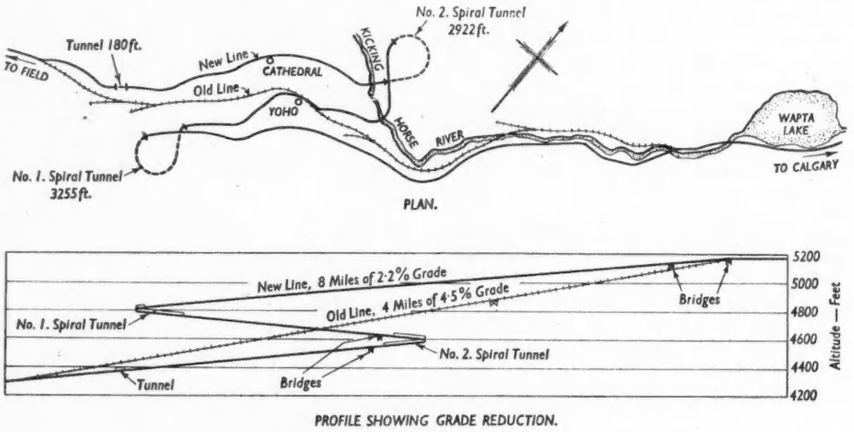


Fig. 2—The Field spiral tunnels

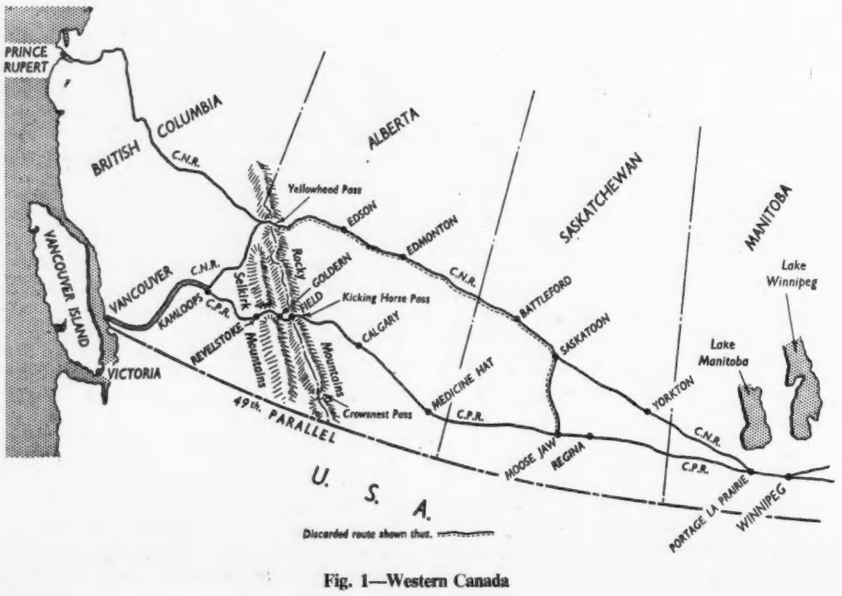


Fig. 1—Western Canada

dry belt, and has since been proved unfit for wheat growing on that account. " Wealthy cattle companies had their grazing lands in the south "—this is more reasonable, but the said companies would certainly have extended their ranges to the north once a railway went through. " Settlement in the north was thinner "—but that would mend itself, and has definitely done so since. " The C.P.R. wanted to be near enough to the Canadian/U.S. border—the 49th parallel—to keep out the Northern Pacific "—this sounds very likely. " The climate farther north was too severe, and the snowfall heavier "—decidedly far fetched, the opposite being the case at any rate as regards the snowfall, which is moderate in the wide open Yellowhead, and very heavy farther south in the Rockies and Selkirks. Mr. F. G. Roe, a well-known western Canadian writer and ex-railroad man, has given considerable attention to this matter in *An Unsolved Problem of Canadian History*, advancing the theory that real estate interests, an ever potent factor in the opening up of the West, may have been the nigger in the woodpile. Thus; the northern survey approved by the Government, if adopted, would have taken the line through Battleford and Edmonton, where the land for right of way, shops, &c., would have to be bought, and Mr. Roe considers the objection naturally entertained by the promoters to buying anything which they might get elsewhere by free grant sufficiently cogent to account for the change of plan. This is speculatively interesting, but does not altogether convince me ; after all, the southern route took the line through Calgary, where presumably land would also have to be bought. The company's own explanation, recently given me, includes several factors, which together were probably weighty enough to have turned the scale in favour of the southern location. It states that the Yellowhead route was discarded in 1881 because (*a*) the presence of coal was suspected near the projected southern line ; (*b*) there is some evidence that military reasons were given consideration, boundary trouble having previously cropped up between Canada and the United States, in both east and west ; (*c*) the urgent necessity to complete the railway through to the coast by the shortest route and as quickly as possible, in view of British Columbia's threat to secede, and become part of the American Union, unless rail communication with the East was achieved by a given date. Finally, Murray Gibbon's *Steel of Empire* puts forward a plausible suggestion that J. J. Hill, chief construction engineer in the West, who had extensive fuel interests, heard reports of coal-bearing areas in the southern parts of both Alberta and British Columbia, which convinced him that it would be more profitable to locate the transcontinental line nearer the international boundary. No doubt he was right—more profitable for him, at any rate.

But however all this may have been, the southern and harder route finally was decided upon, and on December 20, 1881, the company made application for legislation permitting the construction of the line otherwise than through the Yellowhead Pass, which was granted, provided that it went through the mountains not more than 100 miles north of the boundary. In September, 1882, the Kicking Horse route was approved by the Government, which made the Big Hill inevitable, as it involved passage down the narrow, winding valley of the Kicking Horse River, where there was not room to zigzag. On completion, this became one of the most spectacular stretches of track in Canada, and so it remains ; unique so far as Canada is concerned by virtue of its relocation, loops and spiral tunnels. Switzerland can show plenty of the same sort of thing, of course, in particular on the approach to, and in the St. Gotthard tunnel ; in fact, it was from this piece of line that Switzer, the engineer of the spirals, derived his inspiration. The cross-section of the tunnels is none too generous for powerful modern steam locomotives, and they were not ventilated ; when three big engines are heading a 1200-ton train climbing through them on full throttle, at 10 m.p.h., the heat is infernal, and near suffocation results, as I have found many times, especially when on the train engine. The last time I experienced this foretaste of Hell was in 1951, on No. 5935, 2-10-4, the last steam locomotive to be built by the C.P.R.; subsequently passage has been made on diesels, in perfect comfort but some boredom—incredible though it may sound, I thought with nostalgic regret of the stifling cab of No. 5935. My heart is *not* in diesels—one might as well ride a tram. But I am digressing—even as, let it be noted, the track down the Pass ultimately was forced to do.

Fig. 3—Eight-wheeled wooden cars and wood-burning locomotive

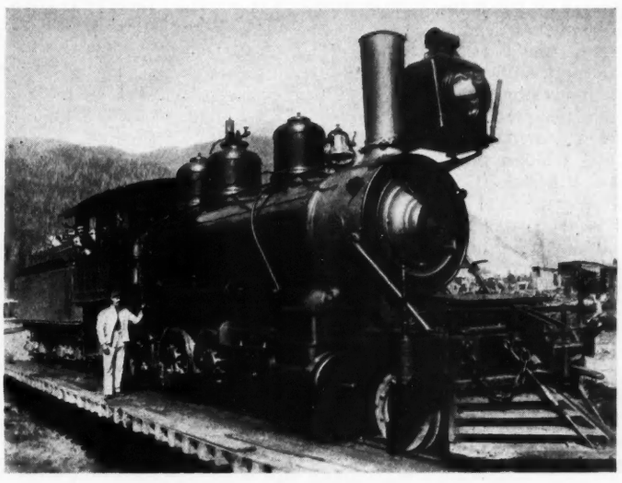


Fig. 4—Baldwin 2-8-0 coal-burning locomotive

Construction of the Big Hill took place in 1884–5 (Fig. 2) ; originally it comprised 4 miles of 4·5 per cent gradient, 1 in 22, beginning a little west of Stephen, where the main line of the C.P.R. reaches its greatest altitude, 5332ft. Thence it descended to Field, a divisional point, 14·4 miles farther on, where the track falls to 4072ft. This stretch between the two stations as first plotted was as difficult and dangerous to negotiate as any in North America ; the scenery was of unsurpassed grandeur, but this probably was not considered sufficient compensation by the people working the incline for the trouble and risks involved in its operation. It remained a source of danger, inconvenience and expense until 1909, when the track was relocated, the gradient being halved by doubling the length of the incline, driving two spiral tunnels under Mounts Cathedral and Ogden, with the result that the original 1 in 22 descent became 1 in 44 compensated, and the worst of the incline 8 miles long instead of 4 miles. No other solution of the problem was possible in view of the lack of room in the valley, complicated by the torrential Kicking Horse River, with its source in Lake Wapta ; moreover, no other practicable way through existed, except far to the south, through the Crows Nest Pass, where later, another line was constructed.

The Kicking Horse Pass had been discovered by Dr. James Hector, attached to Captain Palliser's expedition, in 1857, the name commemorating his attempt to rescue a packhorse from the river into which it had fallen, the animal kicking and nearly killing him in the process. Field became the divisional point, a few miles beyond the foot of the incline, where " pusher " engines were shedded and crews changed — and time changed, too, one hour—it still does. In the early days Field consisted merely of a few shacks, hostel, roundhouse and turntable, three small sidings and a box-car station. The little shack town lay beside the Kicking Horse River, here a shallow, milky snow-fed stream meandering about over a ¼-mile wide gravelly bed on its way to a junction with the Columbia at Golden. Field has changed considerably since it came into being, but has never been anything more than a railway

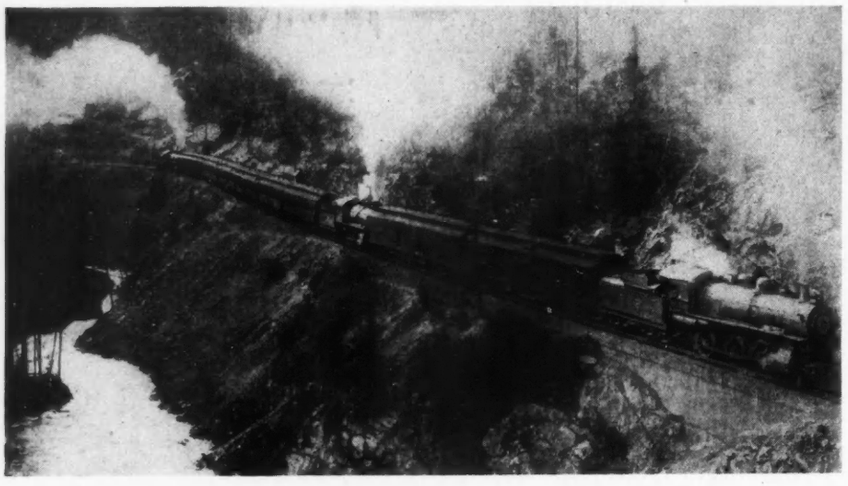


Fig. 5—Triple-engined passenger train on the Big Hill

divisional settlement cowering at the feet of towering mountains, which keep most of the sun off in summer, but none of the cold in winter—58 deg. below zero was recorded there in 1951, an exceptionally severe winter. Field has lost much of its old-time glamour and life now that the trains are no longer steam operated; the " pushers " have either been scrapped or have had jobs found for them elsewhere ; the place is quiet, half dead —but I admit a lot cleaner than it was ! The diesels have taken most of the romance out of railroading in the mountains ; the men say so, and I agree with them. Even the men themselves are different ; they were often " boomers " on the Big Hill in olden days, sometimes from the United States, who lived in cabooses (Anglicé, Guard's vans), ate at a log shanty, y-clept a hotel, drinking and gambling away their off-duty hours because there was nothing else to do. Incidentally, a " boomer " is a transient railwayman with a wanderlust, never staying put very long; there are few of these left nowadays—fortunately. No—Field is not what it was.

To control runaway trains in some measure on this tremendous 1 in 22 incline, four catch sidings were provided at intervals down the declivity ; they will be seen on the plan (Fig. 2). The switches leading into these funk-holes were in the constant care of switchtenders, and normally were set for entry to the sidings, trains stopping or slowing before reaching them, and proceeding only after signalling by whistle, or flag, that they were under control ; the switches would then be temporarily reset for the main line. The sidings were laid with a terminal upgradient of 5 to 7 per cent, which was considered steep enough to halt any train turned into them. This, at any rate, was the theory, but in practice things did not always work out so satisfactorily. Coming down the incline the first siding could generally be trusted to do its job, a train out of control at that point not being likely to approach very fast, but at the other sidings farther down conditions were apt to be different, as a train diverted into them at speed might be derailed on entry or overshoot the stops. If allowed to continue down the line at an increasing rate, however, there was at least a possibility of control being regained before (*a*) Field was reached, or (*b*) it left the track at a curve *en route* thither. The problem " to switch or not to switch, that is the question," was accepted as a calculated risk, and had to be solved by the switchtender in a hurry, leaving him in the position of an ass stooping between two burdens, uncertain which to tackle. He had to decide without peradventure whether to turn the train into a siding and perchance wreck it, or let it continue its flight towards Field and perhaps pile up in another man's territory. No doubt the latter solution was sometimes arrived at as the lesser of two evils ; if it " paid off," and nothing untoward happened, the switchtender could plume himself on his good judgment ; if the worst came to the worst—but let us draw a veil over the subsequent proceedings. From all this it will be seen that working trains over the Big Hill was never a casual routine affair undertaken lightly ; there were difficulties to be overcome, and risks faced whichever direction trains were heading, up or down, the latter probably being the most dangerous ; in winter, still more so.

Passenger trains generally consisted of five cars, with a 4–6–0 engine in front and a 2–8–0 Baldwin " Consolidation " (Fig. 4) acting as pusher behind.* When there were more than five cars a third engine might be dovetailed into the middle (Fig. 5) ; at first, freight trains were limited to fifteen cars, but on more powerful engines becoming available loads were increased proportionately, until by 1909, when the Big Hill became only a name, the " Spirals " taking over, four engines were hauling 700-ton trains up the incline. Engines were fitted with both steam and air (Westinghouse) brakes, the latter on the tender only ; passenger trains were air-braked throughout, but freights were hand-braked, on one truck—all cars were eight-wheeled—by means of a horizontal wheel applied from the cat-walk on the roof, along which the brakemen strode nonchalantly from end to end of the train, in wind, rain or darkness, at speed or on curvature, jumping the gaps between the cars, applying brakes, and so forth. They still do so, though these risky gymnastics are not so frequently necessary in these days of universal " fitted " air-brakes. The couplings on the front of the engines were big double goose-necked drawbars pierced by a hole for the pin (Fig. 4). Two engines of the above type could control twenty cars going down the hill, and take five up ; freight rolling stock was of the box or flat-car type, of 15-ton capacity—they are now perhaps 70-ton. Fifteen-car freight trains called for three engines—ahead, in the middle and rear respectively. Passenger coaches were of wood construction, eight-wheeled, (Fig. 3) except diners and sleepers, which were twelve-wheeled.

The engines were of various classes ; the Baldwin 2–8–0s (Fig. 4) had 20in by 26in cylinders, and 48in driving wheels ; in 1904 a number of them were fitted with 21in by 28in cylinders and 58in wheels. The 4–6–0s built in 1903 had cylinders 21in by 30in, and 63in wheels—they were Schenectady machines. In 1909, the company turned to the Mallet articulated type for greater power ; it will be described farther on, as it was quite an original design, almost as unique as the gradient on which it was used.

Two of the most unusual passenger trains ever taken over the Big Hill were those in which the Duke and Duchess of Cornwall and York—afterwards King George V and Queen Mary—and the Governor-General travelled from the East and back in 1901 (Fig. 6). On the return from the coast the two trains ran in close company ; each consisted of ten cars, divided in the middle by three engines —two in the case of the Governor-General's train—with another engine front and rear ; the Royal train is seen in Fig. 6. That the Governor-General's train had only four engines as against the Royal train's five should not be taken as an invidious distinction intended to show the former's lesser importance ; it was due to the fact that not another engine was available at Field to equalise things.

Fig. 6—Royal train of 1901 with ten cars and five engines

(To be continued)

* Putting a " pusher " at the rear of passenger trains has been long forbidden for obvious safety reasons; it is still permitted with freights. The name persists, however, even though the pusher is now a puller.

Woolf's Moorstone Boiler—A Curiosity of History

By MAURICE GREGORY, M.Inst.M.M.

THAT necessity is the mother of invention was nowhere demonstrated more forcibly than in Cornwall during the eighteenth century. Engineers in that county were in the forefront in attempting to improve and cheapen the means whereby the mines could be kept drained to enable the miners to go deeper in their search for tin, copper and other valuable minerals. The heavy expense of running their large steam pumping engines was directly due to the high cost of coal consequent upon the mines being situated a long way from collieries. The saving of this necessary commodity was an incentive to much experimenting. One of these experiments was the utilisation of the waste heat from copper roasting and smelting furnaces whose hot gases were led through copper tubes set in a moorstone boiler, unique in engineering history.

Fig. 1—Remains of stack showing the two flue entrances as it appeared in 1935. Demolished in 1950

The heat emanating from the furnaces at the Bullen Garden mine which later formed a part of the famous Dolcoath mine, aroused the interest of the early Cornish engineers about the middle of the eighteenth century. They conceived the idea of utilising it for the production of steam for the Newcomen engines then working which were insufferable coal consumers. Pryce, in the appendix to his *Mineralogia Cornubiensis*, 1778, says, when speaking of these engines . . . " but the vast consumption of fuel in these engines is an immense drawback on the profit of our mines for every fire engine of magnitude consumes £3,000 worth of coal per annum. We have several fire engines that are perhaps the largest in the kingdom, the house cylinders are generally from 54 to 70 inches diameter " ; and after commenting on various devices tried out to bring about a coal economy, he remarks : " some have used a double boiler so that the fire might act in every possible point of contact and others have built a moorstone boiler heated by three tubes of flame passing through it." Thus, Pryce confirms that granite boilers were constructed prior to 1778. Nicholson, in his *Journal of Philosophy*, Vol. VIII, mentions them as being in use around 1764.

There is no direct evidence as to who first conceived the idea of constructing a boiler made of granite, but the principle of utilising the waste heat of the roasting furnaces was apparently the outcome of a company of gentlemen connected with Bullen Garden mine resolving to erect a Newcomen engine and put up a set of furnaces that they might avail themselves of this superabundant heat to raise steam, and to effect this they had their engine boiler constructed of moorstone.

About this time a certain Arthur Woolf was engaged at this mine as a " Bal " carpenter. Mine carpenters in those days were Jacks-of-all-trades. Woolf must have been above the average, for he was employed on the reconditioning and erection of this second-hand engine and must have been closely associated with the construction of the granite boiler as well. This Woolf had a son, also called Arthur, who was engaged by Richard Trevithick as an engineer at Dolcoath. Woolf, Junr., became an engineer of repute and experience both in Cornwall and London, and we hear of him erecting engines in the provinces. On his return to Dolcoath he carried out some investigations with a view to improving the efficiency of their steam-raising methods prior to the addition of a further boiler which they contemplated installing. He soon discovered the defect and found that by altering the position of the exit of the boiler flue in the chimney stack from a higher point to a lower, a vast improvement was thus effected in steam raising and, in consequence of which, the new boiler was not required and Woolf was handsomely rewarded by the Dolcoath mine adventurers. The two entrances to the stack, the old higher one and the new lower one, can be detected in the accompanying illustration of the old stack (Fig. 1). So, whether the boiler gets its name from the elder or junior Woolf is a moot point and apparently must remain so.

Why was it constructed of granite ? Probably the reason lay in the difficulty and cost of obtaining wrought iron plates of sufficient size and uniformity to construct a boiler large enough to fulfil the special requirements. Boiler plates in those days were hand forged, the maximum size being about 2ft or, at most 3ft, by 1ft, made from Spanish iron bar 2in square, " red-short " and difficult to work up. The irregularities in thickness around the edges made it necessary to use hemp rope jointing between the riveted plates in the few cases where they were tried. Even with this packing they leaked badly though the steam pressure was

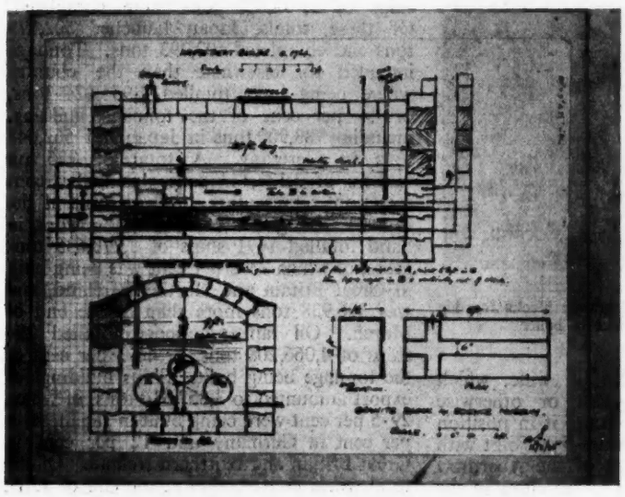


Fig. 2—Longitudinal and cross section of boiler according to Smeaton's notes

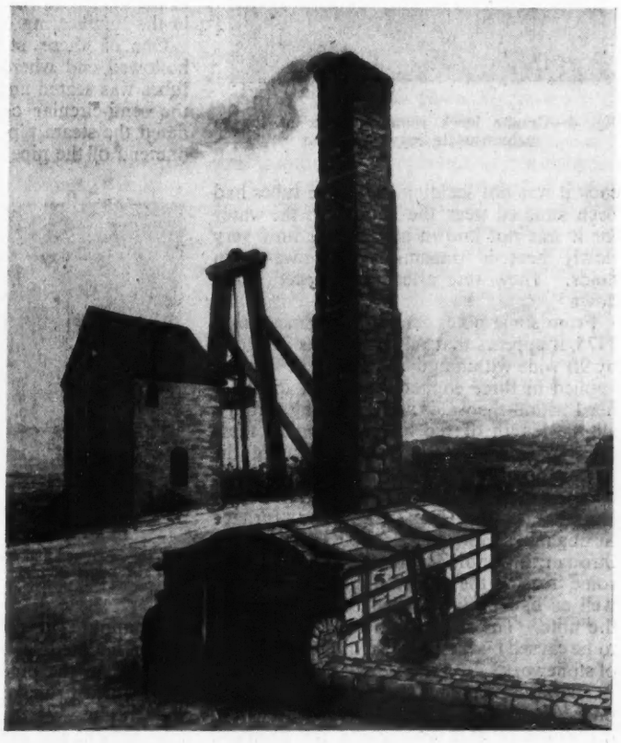


Fig. 3—Artist's impression of the boiler and stack when working. Newcomen's engine house on left

only around 2 lb per square inch. Carefully cut granite blocks channelled and keyed to keep them in place and " break " the joints, which were suitably cemented, was considered a better proposition.

Exactly how these boilers were constructed cannot be better described than by the information handed down to us by Mr. J. C. Hornblower, of compound engine fame, in Nicholson's *Journal of Philosophy*, Vol. VIII, page 169, and also a *Treatise on the Steam Engine* by John Farey, 1827, page 236, as follows :—

" The engine boiler was built of granite called moorstone in Cornwall ; the masonry well jointed and put together with a sort of lime brought from Aberthaw in South Wales which has the property of setting under water. To communicate the heat to the water, copper tubes were placed within it passing horizontally through all the length of the boiler from end to end. The furnaces were placed at one end of the boiler and the flame from them conveyed through the tubes. At the bottom of the boiler was a cock as usual to draw off the water when it was required to clean it and it was discovered that when the fires were lighted and the water in the boiler made to boil so as to afford enough steam to work the engine, still, on drawing water from the bottom part of the boiler by this

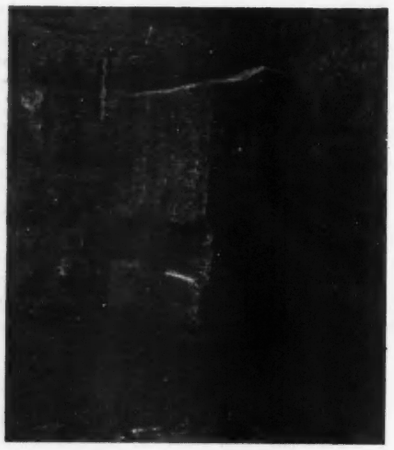


Fig. 4—Granite block showing radius at top to accommodate copper fire tube

cock it was not scalding hot. The tubes had been situated near the surface of the water for it was not known at the time how very slowly heat is transmitted downwards in fluids. They were afterwards placed lower down."

From some notes sent to Mr. Smeaton in 1775, it appears that this boiler was 20ft long by 9ft wide within and 8½ft deep, the fire was applied in three copper tubes 22in diameter fixed within the water and extending through all the length of the boiler. Two of these tubes were finally fixed within 7½in of the bottom and the other one was over the space between them at 2ft above the bottom. The flame was conducted from the furnace through the third so as to pass three times through the whole length of the water. For some reason the boiler did not answer as well as had been expected in practice, says the note. The failure was thought by some to be caused by the heat lost in the great mass of stonework.

The accompanying sketch and the artist's impression (Figs. 2 and 3), compiled from the available data and giving the principal dimensions, show the boiler to have been strapped together with iron braces, the ends being secured with " lambs'-tails " (cotters). But the latter proving a failure, the ends were threaded and nuts provided for the purpose of drawing them up. A screw plate was used for threading the ends, the first occasion on which a screw plate was used in Cornwall, and it was considered of sufficient importance

Fig. 5—Granite block showing half round channel to accommodate steam pipe. Groove at bottom received flange on pipe. Fragment of Aberthaw lime cement is seen at right hand of groove

and interest to be handed down by the blacksmith who made it in Perran, near Marazion, as a wedding present to his grandson.*

Three of these boilers were constructed, one at Bullen Garden mine, one at The Weith, in Camborne, and one at the Gwallon Mine in Ludgvan.

A few of the old granite blocks have been preserved. One from the main body of the boiler is on view at the Science Museum. Four others are now in the care of the Cornish Engines Preservation Society. Two of these are standing beside the 90in Harvey's engine house at the old East Pool and Agar Mine, near Redruth, and the remaining two have recently been housed in the cataract chamber of the old Rostowrack engine being exhibited in the Engineering Museum in Camborne.

One of these stones (Fig. 4) shows the hollowed end where one of the copper fire tubes was seated and another (Fig. 5) shows the semi-circular channel which accommodated the steam pipe of 6in diameter. Near one end of the pipe channel a groove can be

Fig. 6—Tongued and grooved granite blocks forming part of main structure of boiler

seen about ½in deep by ½in wide, which accommodated a ring cast or otherwise fastened to the pipe to secure it in position and helped to make a steam-tight joint with the granite. A fragment of the Aberthaw lime cement still adheres to the stone in the flange groove and can be seen in the original photograph. The remaining engraving (Fig. 6) shows stones from the main structure.

Fig. 1 shows what remained of the chimney stack in 1950, when it was demolished. It was built of granite and lined with brick. This stack appears in some old prints and engravings of Dolcoath and later photographs. Fig. 3 is an artist's conception of what the boiler looked like with its stack and the Newcomen engine house on the left. It was done by Mr. C. N. Roberts, of Camborne, to whom the writer is indebted for permission to publish it. It will be observed that the attendant is holding his hand under the open cock at the bottom of the boiler with impunity.

The writer also wishes to acknowledge the generous assistance afforded in 1935 by Mr. A. Stowers, the president of the Newcomen Society, and South Kensington Museum, as without his assiduous co-operation at the British Museum Library, the task of consolidating the scattered and sketchy data would have involved many more months of patient research.

* *Life of Richard Trevithick* Vol. I—1872 by Francis Trevithick. E. & F. N. Spon.

Lloyd's Shipbuilding Returns

THE shipbuilding returns for the quarter ended June 30 have been published by Lloyd's Register of Shipping, and in Great Britain and Northern Ireland the work in hand amounted to 326 steamships and motorships of 2,060,763 tons gross, or 25,499 tons less than the previous quarter. A total of 60 ships of 407,593 tons were commenced, while 72 ships of 369,250 tons were launched and 81 ships of 445,170 tons were completed during the quarter. Tonnage for which plans had been approved or material ordered amounted to 2,404,054 tons, of which oil tankers represented 54·5 per cent. For registration abroad there were 64 ships of 402,892 tons, the lowest since September, 1946, and representing only 19·6 per cent of the total tonnage under construction, compared with 40·4 per cent, or 825,745 tons, in September, 1950. Oil tankers building totalled 69 ships of 929,085 tons gross, or 45·1 per cent of the ships under construction. Abroad the work in hand amounted to 1365 ships of 6,717,872 tons gross, an increase of 422,437 since the last quarter and 1,400,000 tons more than a year ago.

During the quarter 517 ships of 2,099,961 tons were commenced and 448 ships of 1,795,171 tons were launched, while 402 ships of 1,732,027 tons were completed. Of these totals, Japan launched 502,873 tons and completed 600,293 tons. Tonnage intended for elsewhere than the country where being built totalled 2,954,424 tons, or 44 per cent of the tonnage building, including 988,900 tons in Japan and 562,645 tons in Germany. A total of 225 oil tankers of 3,137,123 tons was under construction, representing 46·7 per cent of the total. Throughout the world the work in hand totalled 1691 ships of 8,778,635 tons gross, of which 23·5 per cent was being built in Great Britain and Northern Ireland, and was 396,938 tons more than at the end of March. Oil tanker tonnage totalled 294 ships of 4,066,208 tons, or 46·3 per cent of the tonnage being built. Ships building for export amounted to 3,357,316 tons, of which 29·5 per cent were being built in Japan, 16·8 per cent in Germany and 12 per cent in Great Britain and Northern Ireland. Of the total world construction at the end of June, 4,938,531 tons, or 56·3 per cent, were building under the inspection of Lloyd's Register.

Institution of Naval Architects Summer Meeting

(No. III—*Concluded from page* 114, *July* 26)

PROFESSOR E. V. Telfer, vice-president, was in the chair when the second paper was presented on Wednesday, July 10, and this was :

THE PREDICTION OF SMOOTH SHIP RESISTANCE FROM MODEL DATA

By Dr. G. Hughes

SYNOPSIS

A review is given of the results of the work done in recent years in the Ship Division of the National Physical Laboratory on the friction resistance of plane surfaces and the analysis of ship model geosim resistance data. It is shown that there is a close resemblance between the scale effect laws for plane surfaces and for a variety of type of hull form over a wide range of Reynolds and Froude numbers. In general, the rate of scale effect is a little greater for ship models than for plane surfaces at corresponding values of the viscous resistance coefficient. Proposals are made for formulations for the correlation of model data in general and for the prediction of smooth ship resistance.

Dr. Hughes said : In all the geosim analyses we have found that the best correlating slope is in all cases slightly steeper than the one which would be obtained from the plane friction at the same level of the specific resistance coefficient.

Since the paper was written there has appeared another publication from the Swedish tank, where they have carried out a further series of tests on the same "Victory" series and have produced results which show quite clearly that in the low Froude number range the correlation slope required is quite steep and fits in more or less with the other data. But in the higher Froude number range they have not been able to find the evidence for the steep correlation. I am happy to find in that paper the evidence of this natural stimulation occurring ahead of the trip wire, and if account is taken of that these new results fall entirely into line with what is proposed in my present paper.

I feel convinced that the " Victory " series now falls firmly into line with the other series and we have a general agreement in that all these series show this general falling-in with the general smoothness of slope and the rate of fall of the friction coefficient that has been shown by the plane friction formulation.

Discussion

Mr. H. Lackenby : Dr. Hughes compares his formulation with other recent rivals and his accent is on slope rather than on the ordinate of the basic curve. That is all to the good, for two reasons. In the first place it is much easier to get agreement on slope, and secondly, so far as ship/model work is concerned, it is the angle of slope that counts. It is encouraging to see, from his graph showing recent data in relation to proposals for a plane friction formulation, that there is very good agreement between Dr. Hughes's and the Lap-Troost and the Wieghardt formulations.

In view of the conflicting evidence over the last few years, I wonder whether there is such a thing as a unique turbulent friction line. We know that exaggerated turbulence can produce exaggerated resistance. Is there such a thing as natural turbulence ? It seems to me that it must depend on how turbulence is developed, by trip wire, studs, or breakdown of laminar flow. I wonder if these things are really the same thing and whether that might not explain some of the baffling differences found recently in the magnitude of the skin friction formulation.

Section B deals with geosim data and I agree that there are quite a number of snags in this. You can have models too small or too big, and with the big ones the tank boundary interference is the bugbear. It was this which impaired the " Lucy Ashton " geosim results, since all models above 16ft were affected by tank boundary interference. I should like to see these geosims repeated in the new tank at the N.P.L. at Feltham. In conjunction with ship results these geosim results would be most valuable, carried out in the same tank, by the same apparatus and by the same people, which will eliminate all inter-tank differences that we know exist.

Another snag in geosim work is that of separation effects on the smaller models. It is known to be a Reynolds number effect, the tendency to separate being greater with smaller Reynolds number. If separation is present, it seems to me that it will increase the slope of the geosim series. I wonder whether this has any connection with Dr. Hughes's steeper slope which he finds on his three-dimensional models rather than on his planks. If there is separation, how do we know when it has stopped?

I question Dr. Hughes's conclusion (2). He states : " For the same position or value in relation to Reynolds number, the curve of viscous resistance coefficient for any three-dimensional body will be not less steep than given by the plane friction formulation." I agree with that. But then he states : " This conclusion may not apply if there is marked separation of flow in the boundary layer." As I read it, it means that if there is separation Dr. Hughes will expect the geosim slope to be less than the skin friction formulation. I should expect the slope to be greater ; in other words, instead of this conclusion not applying, I would say that it would apply all the more if separation were present.

In conclusion (5) he states that there is no indication of any marked interaction between skin friction and wavemaking resistance. This is very fortunate, if it is true. I think Dr. Hughes has inferred this from the fact that the geosim slopes were not affected by the presence of heavy wavemaking. But I do not think it follows from this that there is necessarily no interaction between the skin friction and wavemaking resistance. It may just mean that the degree of interaction may be the same in each model of the geosim set and may not affect the slope.

In the final section of the paper he puts forward three proposals for ship/model extrapolators. They all seem to have the required steeper slope below R_n 10^7 which is now generally regarded as necessary. I understand that to meet this requirement the International Skin Friction Committee of the International Towing Tank Conference has adopted a local modification of the Schoenherr line. I have compared this with Dr. Hughes's proposals, and as regards slope, it seems to me that there is not much to choose between any of them. There is quite a bit of difference, however, in the ordinates of the curve.

It is not very important which is chosen ; any of them would lead to a more realistic smooth ship prediction than the present empirical methods ; and in time this will lead to more realistic allowances for roughness effect, &c. It is rather embarrassing at the moment when these come out negative. When we have a realistic breakdown of the ship/model correlation into its real components, rather than negative components, we should be in a better position to know where to look for improvement.

Mr. W. A. Crago : I wish to refer in particular to the suggestions made in the paper regarding the limitations of small models. The Saunders-Roe test tanks come into the " small " category and our models are therefore sometimes smaller than those tested at some other establishments. Although usually we conduct ship tests on models 9ft long, we have also had some experience with even smaller models, and this has a definite bearing on the present paper, since it is at the lower Reynolds numbers where there is most difference between the various skin friction lines.

In 1954 we carried out a series of tests on a family of four geometrically similar bodies, which gave us a Reynolds number coverage from 10^5 up to 10^7. The body configuration was made up of a streamlined body of revolution completely immersed and carried on a wide strut. This is not a ship form, but we found it useful to investigate the scale effect. The smallest had a maximum length of about 6in and the largest was just about 5ft long. The latter was, in fact, too big from the blockage aspect, and was therefore tested at the Admiralty Experiment Works.

The tests served to show that satisfactory data could be obtained from very small models at low Reynolds number on a Schoenherr basis. To investigate the problem still further a programme of research on small models of the " Victory " ship and the " Lucy Ashton " has been started. Tests have been completed on a one-eightieth scale " Victory " model, which is very much smaller than we would normally test, but it has served to illustrate certain other aspects of the low Reynolds number region. We have found fair correlation on a Schoenherr basis with the one-thirty-second scale model of the " Victory " ship, in tests conducted at the N.P.L., down to about 6 knots full-scale, corresponding to a Reynolds number of about 4×10^5. I emphasise that this was possible only after we had constructed a very accurate dynamometer for the purpose. In this respect it should be noted that a tolerance of $\pm 0{\cdot}01$ lb on Dr. Hughes's one-thirty-second scale model corresponds to $\pm 0{\cdot}0006$ lb on the one-eightieth scale model, and I suggest that one reason why tests on small models tend to be discredited by authorities from larger tanks is that the dynamometers of the latter are just not suitable for such delicate measurements. Dr. Hughes's point regarding the resistance penalty of the stimulator being a large percentage of the whole with small models is accepted, and although we normally adopt a correct technique in which the mean velocity across the boundary layer and the potential flow in the region of the trip wire is calculated, we feel that a method suggested by Dr. Telfer may prove helpful, in which the stimulator size is varied systematically within the range which gives turbulent flow.

The Schoenherr line is in general agreement with aerodynamic theory and was supported in Schoenherr's original paper down to $2{\cdot}4 \times 10^5$ from aerodynamic sources. I feel that with efficient stimulation and a sufficiently precise dynamometer we have been well served by the Schoenherr mean line.

Mr. A. Silverleaf : In all the work done

during the last nine years the emphasis has been on ships' hull work to enable us to predict ship hull resistance very much more accurately and confidently from model data than we have in the past. The need for an accurate and internationally agreed smooth and turbulent friction line is also very great from the point of view of the propeller designer, who is increasingly concerned with scale effects.

I agree with Mr. Lackenby's remarks concerning the different ways in which turbulence may be stimulated, and suggest that in a great deal of the work done the effects of free stream turbulence levels have not been given full value. I do not think these are important in the work that Dr. Hughes has done, because he always takes the utmost care and special precautions to ensure that the free stream turbulence level had no significance at all.

A point has been made by Mr. Crago which relates to this, on the question of varying stimulator size. It is worth pointing out that in the work at the N.P.L. on propeller scale effects and on stimulating turbulent flow over model propellers this is very much in mind, and a lot of work has been done with trip wires fitted to model propellers with the diameter of the trip wire varying from root to tip.

I suggest that any agreement on skin friction coefficient to which we subscribe and which we adopt should fulfil a certain number of conditions.

First, any coefficient in turbulent and smooth friction lines should have a rational scientific basis, and I suggest that this eliminates the Schoenherr line. Mr. Crago's suggestion that it was agreed by aerodynamic theory astounds me. Secondly, this line must have the correct slope. Its position is relatively unimportant for correlation work. Thirdly, it should be straightforward to apply, and should be in explicit form. This point is trivial if one type of formula is substantially superior to another, but where there is not a great deal to choose between them, let us err towards the side of relative simplicity.

Finally, whatever formulation we adopt must be one which gives positive allowances for roughness.

Mr. W. P. Walker : At the conferences I have watched more and more data piling up and I wanted to know if there was going to be an end product. I persuaded the British team before the last conference that we recommend to the committee when at the Madrid conference that they should come up with this practicable and acceptable solution. To-day we have had this presentation by Dr. Hughes, and I hope that one of these three lines is adopted at Madrid.

Professor E. V. Telfer : In my early work on the subject my chief point of disagreement with everybody else's was that I did insist that the slope of the extrapolator was very much higher for the small models than the Schoenherr or the Hughes approach gave. I am now satisfied we are all agreed that the slope of the extrapolator for small models is much greater than was originally anticipated, and if we take all our formulations together there is no practical difference between them. I hope that in Madrid we shall get some agreement. Dr. Hughes has played a very great part in pin-pointing just how the slope is changing with Reynolds number, and nothing can detract from my admiration of the persevering way in which he has hammered this point home and has brought it out on such a sound basis.

The fifth and final paper presented at the technical sessions at the summer meeting was :

SHIP STABILISATION CONTROLS AND COMPUTATION

By J. Bell, M.Sc.

Synopsis

The paper deals with the development of the control apparatus by the author for the activated fin stabiliser. The failings of the first, a type of on-off control, are given and the performance and features of the present proportional control. Further control developments are proposed and the performance predicted. Methods of computing the performance of a stabiliser include step-by-step computations and analogue computing. Using a number of simple results from the latter and adding them together, the rolling motion of a ship in a sea of complex wave slope can be predicted taking into account all the factors of time delays of measurement of rolling motion, the time delays in the operation of the stabilising means, and the limitations imposed by saturation of the stabiliser. Typical records obtained at sea are given.

Discussion

Commander P. DuCane, R.N.: We have so far avoided the necessity for the withdrawal of the fins into the hull by making use of low-aspect ratio fins, if necessary multiples, whose location is such that the outboard edge of the fins is located well within the maximum beam and above the keel line.

We feel that a correct description of the function of all activated fins at present in use might be roll damping. This arises mainly from the nature of the control signals which activate the fins. In all cases described here a movement of the ship is necessary before a counteracting fin movement can be initiated. This may strictly be applicable to the anticipation gear described in the paper, as well as to the element of anticipation obtained by combining signals from rate gyro with those from vertical seeking gyro with sign reversed, as described in Mr. Bell's contribution to the discussion on Dr. J. F. Allan's 1945 paper, on " The Stabilisation of Ships by Activated Fins."

If it is accepted that " roll damping " is scientifically a more correct term, then it may be considered that mention (in the present paper) of the stabiliser " subtracting " an amount from what would have been the " free roll " is somewhat contradictory. The lift provided by the fins will still be available to damp the motion even after the disturbing wave slope has caused a residual roll to develop despite the opposing fin forces.

I am in agreement that the use of the so-called stabilisation factor is not a realistic means of evaluating the efficiency of a roll damping installation. However, the problem of finding a really satisfactory alternative is worthy of further consideration.

In one of the typical records of stabilisation shown in the paper it seems that the response of the fin to angular velocity is much delayed. For instance, at one point the velocity of roll will have reached zero, yet full fin incidence appears to be applied for some seconds in the direction appropriate to damping the build up in roll prior to reaching that point.

I have a roll record taken aboard our research ship M.Y. " Sea Victory," to which is fitted a " Muirhead " velocity gyro. A study of the fin movement in relation to roll will show that after reaching two points where roll velocity is zero there is only negligible delay in reaching zero fin incidence, while maximum fin incidence in the damping direction is reached just over half a second after those points. It should be appreciated that this fin movement results from the signals received as a result of the build up in velocity as measured by the rate gyro. This result reflects great credit on the Muirhead gyro and on Mr. Bell as the architect thereof.

Mr. J. H. B. Chapman : I think it is true to say that all the Admiralty ships so far fitted have the A.R.L. compensating control. One reason for using stabilising gear is largely to provide a more stable weapon platform, while another is to provide a better working platform for small ships to operate in coastal waters and estuaries. The gear occupies space and adds weight, and therefore it has to be justified. We have not yet proved whether it reduces the consumption of fuel, nor have we proved that in given sea conditions a ship can go faster when using her stabilising gear. However, perhaps these are secondary considerations.

Mr. Bell has brought to notice this refined control gear. I gather from the paper that it has been tried at sea ; we can assume, therefore, that it works in sea conditions. I would like to know whether in fact it introduces any greater problems in connection with maintenance and reliability, whether it is more prone to troubles than is the A.R.L. gear. I should also like to know, if we achieve what he suggests, that the motion of the ship is much smoother and the motion of the gear is much smoother, whether we can effect any savings in respect of the weight and complication of the primary machinery required to operate the fins.

The stabilisation of pitch is perhaps a dream for the big ship, but I think it may not be too much of a dream for the small ship operating in coastal waters.

Mr. Bell briefly replied and said : With regard to Commander DuCane's reference to roll damping, the point is that with this control gear we are trying, not to damp the roll, but to hold the ship at the level. For that reason the general theme is to " catch the roll young " and not to allow it to build up ; then we get a stable ship. The acceleration comes in, and instead of waiting for the fin to go over, as with the old gear, we get the fin over more quickly. A second can be used advantageously in getting work done by the fin to keep the ship in the vertical position instead of rolling. Once a ship rolls, the momentum has to be killed by subsequent fin action ; before a ship gets into regular sinusoidal action, use the acceleration to stop it rolling.

Ionising Radiations in Industry

The Minister of Labour, Mr. Iain Macleod, has announced that a preliminary draft entitled " Factories (Ionising Radiations) Special Regulations," has been published (H.M. Stationery Office, 9d.). A further draft will be prepared for Parliament after any suggestions that are made have been considered. Representations should reach the Secretary, Ministry of Labour and National Service, 19, St. James's Square, London, S.W.1, not later than October 31 next.

The use of radiographic inspection and other such processes in industry is rapidly increasing, and while some of the ionised radiations produced are relatively harmless, others are not. Enclosing sources of radiation in suitable containers prevents dissipation of radioactive substances in the atmosphere, and the draft code deals with such " sealed sources " and with radiations from certain electrical machines. Two methods of protection are envisaged. One is " adequate shielding " with a thick casing round both the source and the work being irradiated. If this is not possible, the method proposed is " adequate protection " with the best shielding that can be arranged, plus limitation of the time spent by any person in the affected zone.

Main Drainage in the City of Kingston upon Hull

No. III—(*Concluded from page* 119, *July* 26)

Humberside pumping station, which will serve the low-lying main drainage area of West Hull and Haltemprice, was inaugurated last Friday at a civic ceremony when Mr. Henry Brooke, the Minister of Housing and Local Government, opened the station. Earlier parts of this article have explained the general scheme of drainage in Hull, and given details of the joint scheme in the western area. Here we conclude an account of the Humberside pumping station.

THE problem of operating such a large number of pumps as are ultimately to be installed at the Humberside station and of bringing them on load in sequence with comparatively small changes in effluent level in the sewer system, is in itself formidable and could not have been achieved by any form of stepped electrode, since the normal surges which arise as pumps are brought in and taken out of service would be sufficient to introduce instability. Careful consideration was, therefore, given to the development of a scheme whereby the lower flows (up to 18,000 cubic feet per minute) could be controlled with a minimum change in sewer effluent level and the method of operating in sequence using stepping relays was specially developed for the purpose and, as far as is known, has not been applied to any other installation in any part of the world. The system is, in fact, a "rate of rise" system; "Noflote" electrodes are used to detect the effluent level in the sumps at regular intervals and any undue rate of rise or rate of fall is interpreted by the control system and increases or decreases the pumping rate by bringing pumps into or out of service.

The two master electrodes are placed about 2ft 6in apart vertically with the normal dry weather flow level about halfway between them. They will be energised at fixed intervals—which can be from three to ten minutes—and actuate stepped relays. If the water level is between the two electrodes when they are energised, the relays will not be affected and the pumps in service will not be changed. If the level is below the lower one, the relays step back one increment, resulting in a pump coming out of service, or vice versa. Thus the pump capacity is adjusted at intervals corresponding to the energising of the electrodes, giving, for practical purposes, a continuous automatic control of the pumping capacity. Each step in the relays corresponds to one dry weather flow pump of 3000 c.f.m. capacity. Pumps may be selected for operation as follows :—

Flow, c.f.m.	Pumps
3,000 ...	Any 1 of 4 dry weather flow pumps
6,000 ...	Any 2 of 4 dry weather flow pumps
9,000 ...	Any 3 of 4 dry weather flow pumps, or any 1 of 6 9,000 c.f.m. storm water pumps
12,000 ...	4 dry weather flow pumps or any 1 storm water pump plus any 1 dry weather flow pump
15,000 ...	Any 1 storm water pump and any 2 dry weather flow pumps
18,000 ...	Any 1 storm water pump and any 3 dry weather flow pumps, or any 2 storm water pumps

Selection of the pumps to be used as the various flows are reached is made beforehand on the control panel. For flows about 18,000 c.f.m. a storm water pump will be started, independently of the control system, which will then function, as outlined above, but over the range of flows 9000 to 27,000 c.f.m. Similarly, other storm water pumps can be started, giving a base load pumping rate so that the control system operates over the upper range of adjustments of flow up to the maximum flow. It has not been considered desirable to extend the range of automatic control above 18,000 c.f.m., although this would merely involve an extension of the relay system, since it will usually be necessary, when this rate of pumping is reached, to review the operating conditions. Depending on the state of weather, the tide, and the probable load on the supply network, it will then be decided whether additional electric or additional diesel sets are to be brought into commission to meet the demand. At periods of potential maximum demand on the supply network it will be necessary to bring the diesel-driven pumps into service first, and it is probable that they will be used extensively as "first call" storm water pumps.

The supervisory and control panel, a closer view of the test and selector section, and a simplified circuit diagram are shown in the accompanying illustrations. Indicator lamps are provided to show which pumps are selected to operate under each particular stage, and also to indicate when a particular stage of pumping is required to operate, the actual operation of all pumps, both under automatic and manual control, being indicated by other lamps. Indicator lamps and interconnected audible alarms are also provided to give warning of fault conditions in any of the pumps, screening machines, penstocks, or auxiliary equipments. An O.C.B. desk has also been supplied to initiate and to indicate the operation of the oil circuit breakers on the station electric supply circuits, and to provide audible and visual alarm under fault conditions. There is a time delay when on automatic control, between the starting of one pump and the stopping of another to ensure continuity of discharge while the new pump is running up to speed.

Screening and Maceration Machinery

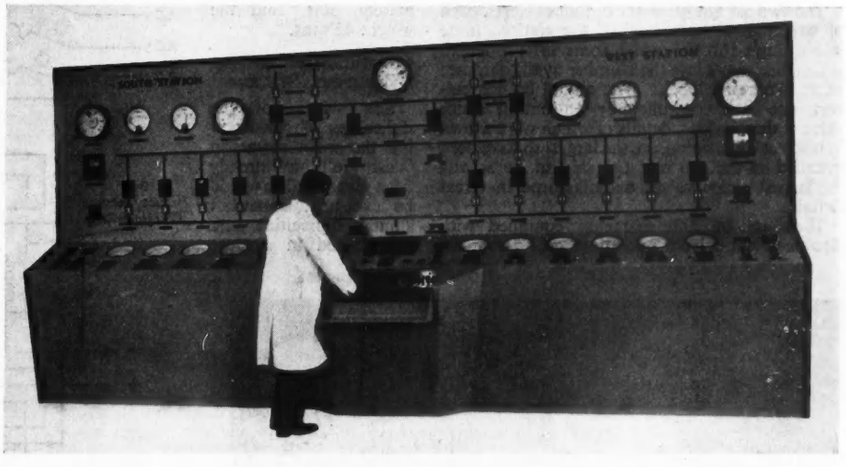
Simple treatment of effluent was considered necessary; possible future requirements of the Rivers (Prevention of Pollution) Bills, the proximity of the entrance of St. Andrew's Dock and the need to reduce pollution in the higher reaches of the river were cited to justify it. The scheme, therefore, does differ from East Hull by including screening of all effluent by ¾in continuously raked screens, the debris from which is macerated before discharge into the river on ebb tides. The screening plant, as we have already indicated (reference to the inset drawing published last week will be helpful in following the description here), has four screening channels, each approximately 11ft in width and the screening is divided into three zones, namely, coarse screens, detritus zone, and fine screens.

The first zone comprises 4in vertical bar screens in tandem, each with automatic electric hoisting gear. These screens are designed principally for the protection of the other parts of the plant from mechanical damage due to the impact of baulks of wood or other heavy material. A screenings collection tray at the frame base can be raised with the screen in vertical guides to machinery floor level; the screenings are evacuated at this point into a steel trough. The driving units are mechanically and electrically interlocked to ensure that one unit is in the screening position before the other can be raised for cleaning. The floor area taken by the screens in their raised position had to be kept to a minimum so movable flooring can be automatically raised from the screen head frame. Full protection is given to the operators, including electrically and mechanically interlocked hand-railing around the floor area. The coarse screenings are transported along the open trough by squeegee to an electrically-operated skip hoist. Screenings are deposited into the skip, which is then raised to ground level, where it automatically discharges into disposal wagons, the skip returning to its home position at machinery floor level.

The effluent which has passed through the coarse screens then reaches detritus pits; these pits are not intended to collect the whole of the detritus in the effluent, since the pumps are capable of handling it, but local experience has shown that there is normally a heavy concentration of grit near the invert of the sewer and a high degree of extraction can be obtained by simple detritus pits and bucket elevators. The elevators operate intermittently according to demand and will lift the detritus from the pits into collecting sumps, where it will be stored prior to discharge to the river at appropriate states of the tide. The detritus and screenings discharge pipework is entirely independent of the main outfall to give the controlled discharge on ebb tides, referred to above. It is hoped also to eliminate silting of the outfall which has been a source of difficulty in the older outfalls in the city.

The final stage of screening is carried out by conventional ¾in inclined bar screens with raking combs operating continuously, and the screenings are waterborne from the headgear to the screening sump. The screens are unusual in so far as they can be lifted from the channels—for instance when large quantities of snow are being discharged into the sewer. This has in the past created difficulty by clogging. Each screening channel is provided with an inlet and outlet penstock to enable servicing and maintenance to be carried out. The screening chamber is arranged electrically in two sections and each pair of channels is controlled from an independent central control position where a large sequence interlocked control cubicle has been installed.

The screenings from the fine screens are delivered into a receiving sump, mixed with diluent water, disintegrated, and then stored in a sump



Supervisory and control panel for the pumping plant at the Humberside station. Selection of pumps up to a maximum of 18,000 cubic feet per minute is made automatically. Operation at higher flows is automatic, over a range of flow of 18,000 cubic feet per minute, the total flow depending on the number of extra storm water pumps brought into use

from which they are pumped to the outfall at predetermined times to suit the tidal flow in the River Humber. This screenings processing installation comprises two vertical disintegrators complete with motors, starters, pipework and valves, together with two vertical anti-choke pumps with similar ancillary equipment. The screenings must be diluted to give a free-flowing mixture moving at sufficient velocity to carry the solids into the disintegrators so that efficient maceration will be obtained.

The disintegrators are designed for primary cutting of larger solids by a stationary blade on the inlet or suction side of the impeller, and the main disintegration is effected by the impeller pumping the material through a stationary cutting plate on the delivery side. Each machine is essentially an axial-flow unit, and each impeller has hardened steel cutting edges on both the inlet and outlet sides of the blades. Some auxiliary cutting is also achieved between the periphery of the impeller blades and the casing. The position of the inlet cutting blade relative to the back plate is easily adjustable, so as to maintain cutting efficiency. Each disintegrator is rated for a duty of 400 g.p.m. of fluid when running at 960 r.p.m. and driven by a 12½ h.p. vertical slipring motor.

The two vertical anti-choke pumps are each designed for a duty of 700 g.p.m. against a total head of 55ft when running at 960 r.p.m. The motors are of 25 b.h.p. and are high-torque squirrel-cage machines. The suction and delivery connection to each of these pumps is 6in in diameter. The macerated mixture from the disintegrators is delivered into a screenings storage sump adjacent to the anti-choke pumps, and to prevent undue settlement the pipework and the valves from the disintegrating pumps are so arranged that recirculation of screenings can be undertaken, and the screenings storage sump can be kept clean by special swivelling hose monitors operated from the floor above. The anti-choke pumps are specially selected, and are capable of dealing with sewage containing appreciable quantities of solid matter, and are constructed with large waterways. The vertical driven shafts of the disintegrators and the anti-choke pumps, are totally enclosed with internal bearings.

Outfall Sluice Valves

The two 9ft 6in diameter outfall culverts, each of which serves one half of the station, unite into a single 10ft 9in outfall some 981ft in length which discharges into the Humber by the entrance of St. Andrew's Dock. The outfall branch culverts are each controlled by an outfall sluice valve ; these valves, details of which were shown in last week's drawing, are the largest to have been installed on the site and are said to be among the largest sluice valves manufactured in Great Britain.

They are of 90in diameter, equipped with electric-motor-driven operating gear, and designed for a maximum working head of 50ft. The casing and gate of each valve are massively constructed in " Meehanite," heavily ribbed. The gate is parallel seated, fitted with solid gunmetal face rings matching with similar seat rings in the body. Machined gunmetal faced gate slides provide non-corrodible guide surfaces.

The lifting spindle consists of a tube, secured to a nut at the head of the gate, and engaging at the upper end a screwed non-rising operating stem external to the valve casing—tube and stem telescoping when the gate is raised. This arrangement gives the same access to the operating threads as the ordinary rising spindle construction, but requires less headroom, and the operating screw can be replaced if ever necessary without a major dismantling operation on the valve. The lifting nut, nut box, tube and stem are of aluminium bronze alloy. The stem revolves in gunmetal bushes in gland and stuffing box, and the load at the thrust collar is taken on ball bearings.

The motor gear unit is standard and is capable of opening and closing the valve against an unbalanced head of 30ft, at a speed of 13in per minute. It incorporates a 15 h.p. flange-mounting motor ; totally enclosed double worm reduction gear, with ball bearings throughout ; and mechanical tapered tooth torque-limiting clutch. The gears and clutch are oil-immersed. The clutch transmits the correct torque for opening and closing (appropriately higher in the first case), and as soon as these values are exceeded, slips and disconnects the drive. As the clutch teeth move out of engagement, the loading arm actuates a trip-switch in the control circuit, and cuts out the motor. In the normal seating operation, it automatically ensures correct register of the faces and tight shut-off without risk of overload.

The overall height of each valve is approximately 30ft, and the weight 42 tons.

Construction of the Pumping Station

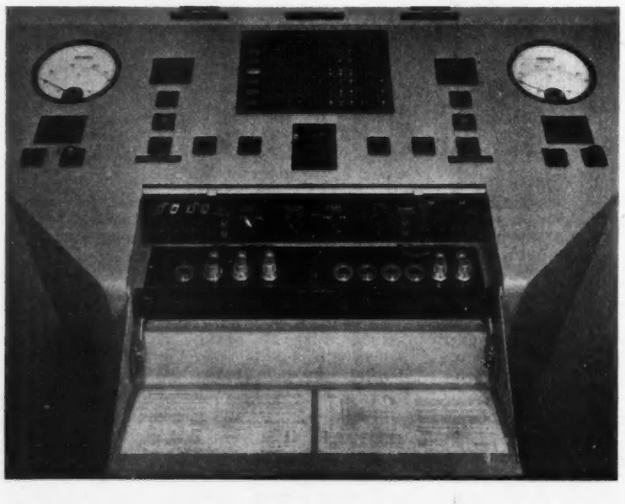
Some idea of the difficulties of constructing the main sewers in West Hull has already been given, and as would be expected, somewhat similar difficulties were experienced in a more acute form in the construction of the pumping station. The site was typical of the weak estuarine materials of the city area generally. The lowest parts of the station have been taken down through the silt, and the deep sumps were founded on laminated clay, and the screening plant area on boulder clay.

One of the first operations, and a most difficult one, was the insertion into an existing 5ft diameter brick sewer of a specially fabricated " Y " shaped steel branch pipe weighing about 6 tons to enable the flow to be diverted ultimately from this existing sewer into the completed new station and also to assist initially in the diversion of a 5ft existing sewer from the site for the new station.

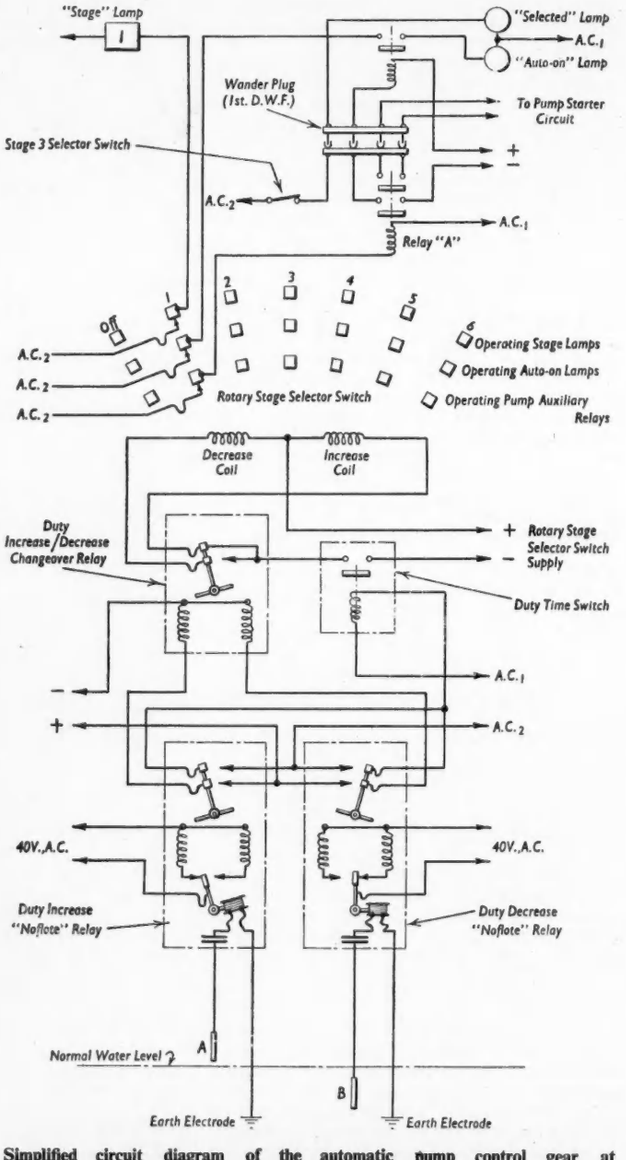
The main cofferdam was divided into two portions, one for the screening section and one for the deep sumps.* The former measured about 110ft by 60ft and was lined with Section 3 Larssen piling. Initially this cofferdam was to be braced with steel walings and box-pile struts, but due to the steel shortage it was necessary to use timber bracing. The screening section cofferdam varied from 45ft to 50ft in depth.

The cofferdam for the deep sumps covered an area of about 160ft square on plan and was taken out to a maximum depth of 63ft in two stages.

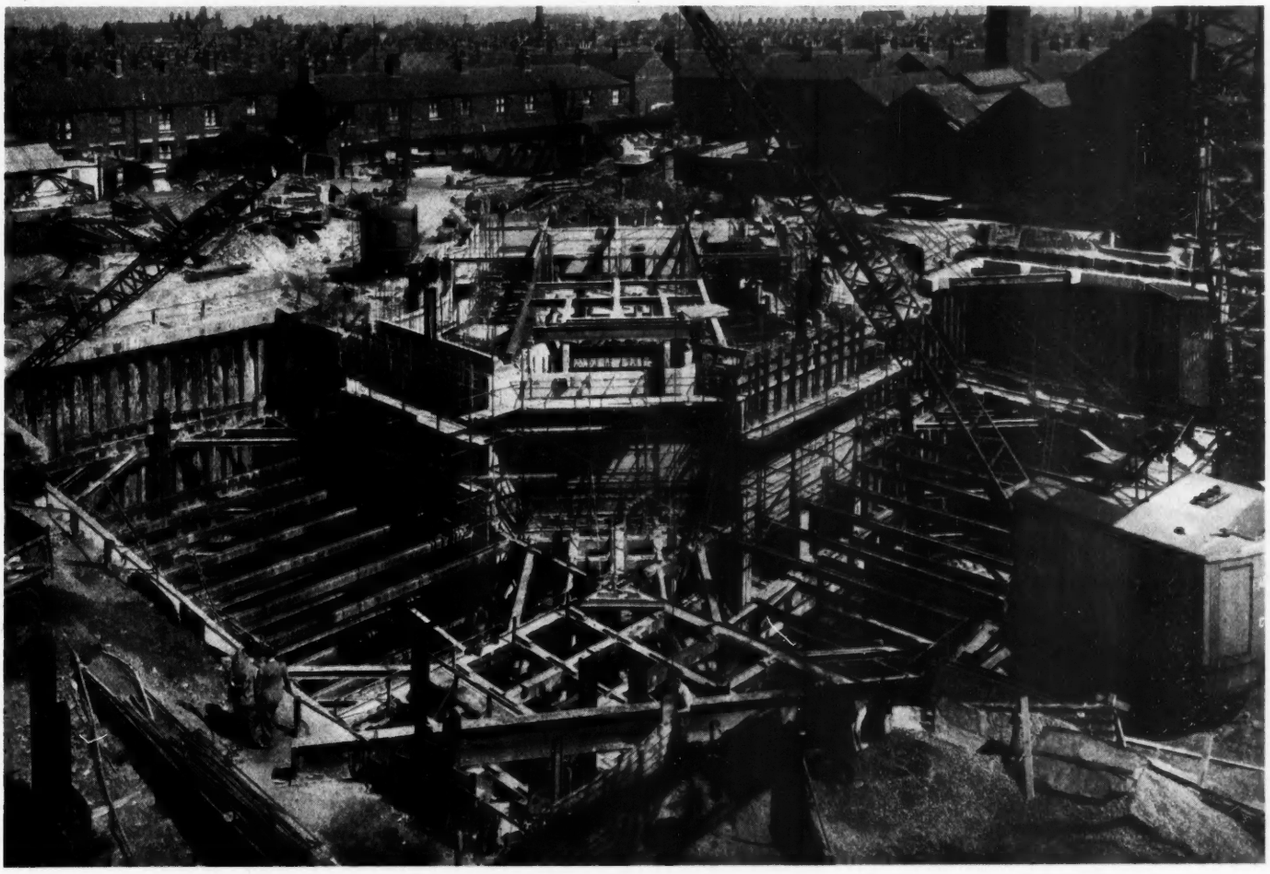
* Positions of the steel sheet piling were also shown in last week's inset drawing.



The test and selector section of the control panel, which is to be seen in the centre of the previous illustration, is shown here in detail. Reference to the text will elucidate the functions of the various controls



Simplified circuit diagram of the automatic pump control gear at Humberside pumping station. The electrodes which detect change in effluent level are marked A and B in the diagram



Humberside pumping station site in June, 1953. Construction of the screening section, in the background, had reached ground level and excavation of the perimeter and deep sump cofferdam was complete. Note the internal cofferdam bracing and the old West District pumping station in the background on the right

The first stage, down to boulder clay (25ft deep) over the whole area of the cofferdam was supported by perimeter piling consisting of Section 4B Larssen held back at the top by tie-bars and anchor piles. Thus no internal bracing restricted the working area at this level. The second stage, down to formation level of the deep sumps, supported an excavation 35ft deep within the perimeter cofferdam and was in Section 3 Larssen piling with R.S.J. walings and box pile struts. This construction can be clearly seen in the general view of the site illustrated above ; a photograph showing the cofferdam bracing is reproduced on page 158.

The Substructure

The substructure of the pumping station itself is composite, and embodies structural steelwork framing in conjunction with reinforced concrete. In the lower parts of the substructure the walls span horizontally between vertical beams braced apart with steel struts. In the higher parts, the walls span vertically between the pump discharge floor and capping beams at motor floor level. The three main portions of the substructure are founded at different levels on different material and carry different loads. The screening section with no superstructure is founded on boulder clay, the deep sump section, with a heavy superstructure, is founded on laminated clays and the delivery culverts, supporting part of the administration block, at silt level. It was necessary to excavate the silt and support the delivery culverts on mass concrete founded on boulder clay below. It was decided, therefore, to provide for differential settlement between these three main sections of the substructure by avoiding any rigid connection between them, a provision which, of course, also had to be extended upwards through corresponding sections of the superstructure. All subsidiary buildings such as switchgear houses, loading bays, transformer houses and diesel engine houses are supported on bored r.c. piles.

Major redesign of both the temporary cofferdams and the permanent work was necessary after work on the site had commenced due to the shortage of all classes of structural and reinforcing steel. The water-retaining portions of the structure have been designed in accordance with the " Code of Practice for the Design and Construction of R.C. Structures for the Storage of Liquids," published by the Institution of Civil Engineers. To provide additional weight to counter flotation, a ledge was provided on the base slab to project outside the main walls, the space above this ledge up to ground level being filled with sand consolidated by water. Water bars used varied according to position and included crimped copper set in a bitumen-filled chase, patent rubber or P.V.C. water bars and stainless steel strip. To reduce the possibility and size of shrinkage cracks, slabs and walls were cemented in panels separated by narrow junctions or shrinkage panels. The latter were concreted fourteen days after the casting of the main panels. Where structural steel was likely to be in contact with sewage, the steel has been encased in concrete which has in turn been protected with a skin of impervious ceramic shrouding. Where sewage will be in contact with the structure, the concrete floors and walls have been lined with engineering brickwork.

The Deep Sumps

The contractor commenced work on the cleared site in January, 1951, concentrating initially on the various diversionary works and on the construction of the two inlet culverts followed by driving the cofferdam piling. Progress was immediately retarded due to the non-delivery of steel sheet piling, structural and reinforcing steel, but apart from this, construction of these works and of the screening section, we are informed, proceeded without major incident. The screening section was generally completed by March, 1954. Settlement damage occurred to the boiler house of the old station alongside the screening section cofferdam and it was ultimately necessary to dismantle a section of the boiler house and resite a boiler on new piled foundations.

Excavation to formation level in the deep sumps was completed by mid-1953, water not being encountered until a depth of about 45ft below ground level. Thereafter, numerous " blows " developed necessitating the use of sub-drains and sumps from which continuous pumping was necessary. The water appeared to originate from the chalk strata between 70ft and 80ft below ground level, formation level of the deep sump section being in places 63ft below ground level. At the deepest part of the excavation a stratum of running sand was encountered which involved minor amendments to the base slab to avoid working in the stratum.

In the east deep sump, by the old pumping station, the bottom of the excavation at formation level was found to consist of soft plastic clay which tended to lift due presumably to hydrostatic pressure from the water in the chalk some 15ft below this level. When the first 15ft wide bay of the 12in site concrete was poured it was loaded as soon as possible with skips filled with surplus spoil, but despite this, the following day it was found to be badly cracked and had lifted some 12in. This upward movement of the clay bottom permitted the toes of the piles to kick inwards and urgent preventative measures were taken to arrest this movement and thus prevent loss of ground or a cofferdam failure, both of which would have undoubtedly resulted in serious damage to the old pumping station.

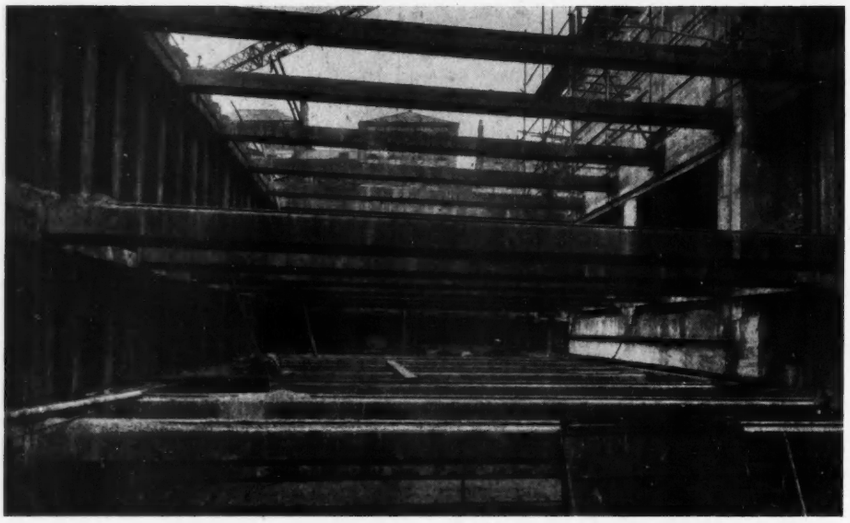
An r.c. beam was cast *in situ* along the toes of the end piling anchored into the interlocks of the side sheet piling of the eastern section of the cofferdam and this heavy beam was effective in preventing further inward movement. The next bay of site concrete was then poured at a somewhat lower level to allow for possible uplift, and although some cracking and lifting did occur, it was insufficient to require the breaking out of the concrete.

The first bay of concrete was then broken out and repoured, and the base slab proper, some 4ft thick, was constructed over the first two bays of site concrete as quickly as the fixing of the substantial reinforcement would allow. This manœuvre was successful and no further trouble

of this nature was encountered, although much of the remaining base slab was at lower levels.

Excavation in the deep sump section as in the screening section was carried out mainly by an excavator with face shovel front end equipment. The last 5ft were taken out in 15ft bays by hand and mechanical grab, the object being to remove the dead load of earth at formation level over relatively narrow strips over which a section of the thick base slab could be constructed in the minimum of time. It was hoped that this would prevent uplift of the ground at formation level due to hydrostatic pressure from the chalk below and except for the section first excavated and referred to above, these measures proved successful.

The base slab of the deep sump section was completed by the end of July, 1953, the pumping sump being finally sealed off at a later date when the walls of the structures had been constructed high enough to exclude water which rose outside them when the sumps were concreted. Thereafter, constructional work proceeded without



Wet sump during construction of base slab. Note cofferdam bracing of box-pile struts, and entry culverts from the screening section on the right

major incident, the walls of the structure being either lined with a 4½in skin of engineering brickwork, where they are to be in contact with sewage, or light-coloured Ruabon bricks. In both cases the 4½in thick skin of brickwork was constructed first in lifts of 3ft to 4ft to provide internal shuttering for the r.c. walls.

Bad weather early in 1954 caused considerable delays to the constructional work, but construction of the substructure was substantially completed by the end of the year. Some trouble has been experienced due to leakage of water in various parts of the substructure and specialist remedial measures have now practically reached a successful conclusion. In April, 1954, the two 96in diameter outfall culvert sluice valves, the heaviest section of which weighed approximately 13 tons, were lowered into their positions some 20ft below ground level. The main castings were too heavy to be handled by the contractor's derrick and as no suitable mobile crane was available in the district, the contractor decided to place the castings on timber cradles and slide them into position down a ramp constructed of tubular scaffolding with heavy timber runners to take the cradles. Movement of the castings was controlled by winches and restraining tackle and after a trial using a dummy load of 15 tons, the castings were successfully lowered and winched into position. Due to the special nature of the castings any major damage to them resulting from these operations would have involved very substantial delay in the construction of the pumping station.

Some 1000 tons of steel sheet piling were used in the work, of which about 860 tons were left in, either to safeguard existing buildings and services or because it was found uneconomical to extract. About 370 tons of structural steelwork and thirty-eight standards of heavy baulk timber were used in bracing the cofferdam. Other quantities of materials in the substructure are :

Excavation, cubic yards	46,000
Concrete, tons	20,000
Sulphate-resisting cement, tons	3,000
Reinforcing steel, tons	600
Permanent structural steel, tons	310
Bricks	700,000
Major drawings	500

Pumping Station Superstructure

Work on the construction of the superstructure started in January, 1955, and the shell of the building was completed by mid-1956, leaving only the various internal finishings to be completed as the installation of the mechanical and electrical plant permitted. The contractor has made extensive use of a tower crane, mounted on a rail track set up inside the building, in the constructional work. In the final stages the crane was moved outside to complete the construction.

The building, which has a floor plan area of about 16,000 square feet, is of single-storey construction except for the administration block, which has two storeys. The motor halls are 44ft high internally and are framed in reinforced concrete with 15½in cavity panel walls in brickwork and "reconstructed stone" facings. To minimise the noise transmitted from the building, the windows of the motor halls and diesel houses are of glass blocks. The most economical design for the main motor halls has proved to be a series of four-sided portal frames, the lower horizontal members being formed by the motor hall floor beams constructed as part of the substructure contract. In this way the transmission of heavy bending moments from the superstructure to the walls of the substructure has been avoided. The motor floor design has proved very complex because of the large holes (approximately 18ft by 8ft) for the pump motors and numerous smaller holes at set positions for valves, cables, pipes and accesses. In addition, the floor beams have been fixed at irregular spacing due to the requirements of the machinery layout, and since these beams must coincide with the superstructure framing, the superstructure elevation has been greatly influenced by the plant layout. Provision for differential settlement between sections of the superstructure has been made corresponding to that in the lower levels in the substructure.

A detailed scale model of the pumping station substructure, superstructure and ancillary works was constructed in the city engineer's workshops, including models of the major mechanical and electrical plant. This model proved of immense value, we are informed, and has been demonstrated at various engineering exhibitions in the country.

The schemes for remodelling the drainage in Kingston upon Hull itself, both in the east and the west sections, is under the direction of the city engineer, Mr. William Morris, O.B.E., M.I.C.E., and the design work and supervision are being carried out by his staff, including the mechanical and electrical engineering design of the Humberside station. However, the joint engineers for the West Hull and Haltemprice joint scheme, which has been our principal subject in this article, are Mr. R. B. Heseltine, A.M.I.C.E., engineer and surveyor of the Haltemprice U.D.C., and Mr. Morris.

The main contracting firms concerned in the erection and the supply of plant for the Humberside station are as follows :—

Civil engineering : pumping station substructure, Earth and General Contracts, Ltd.; superstructure, Frank Haslam, Ltd.

Electrical and mechanical engineering : main pumping machinery, Gwynnes Pumps, Ltd.; subcontractor for electrical plant, The Metropolitan-Vickers Electrical Company, Ltd., and for diesel plant, Mirrlees, Bickerton and Day, Ltd. The subcontractor who developed and supplied the stepped electrode control system was Evershed and Vignoles, Ltd. (in conjunction with the main electrical contractors), and important subcontracts for valves and steelwork were placed with Glenfield and Kennedy, Ltd., and Allen Kennedy, Ltd., respectively.

The principal contractor for power supplies is the Yorkshire Electricity Board, and switchgear is being supplied by A. Reyrolle, Ltd., the Metropolitan-Vickers Electrical Company, Ltd., and Brookhirst Switchgear, Ltd.

The screening plant and penstocks were supplied by William E. Farrer, Ltd., the macerating pumps by Sulzer Brothers (London), Ltd., the outfall sluice valves by J. Blakeborough and Sons, Ltd., and the machine room cranes by Sir William Arrol and Co., Ltd.

World Oil Industry

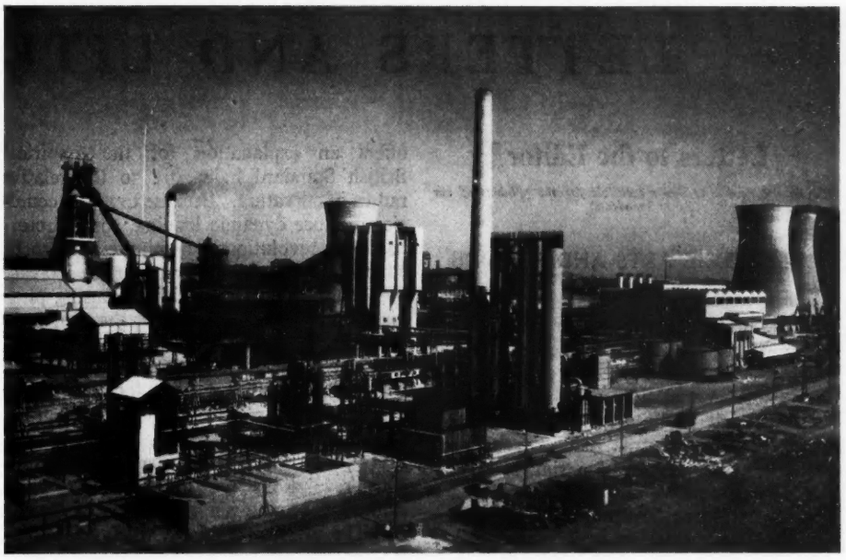
The British Petroleum Company, Ltd., has recently published its *Statistical Review of the World Oil Industry*, 1956, which deals with questions relating to oil reserves, production, consumption, supply and demand, refining and oil tankers. Proved oil reserves rose from 26,055 million tons at the end of 1955 to 31,245 million tons at the end of 1956, with the main upward revision being in the Middle East and in Russia so that 76 per cent of the world's oil reserves are estimated to be in the Eastern Hemisphere. Figures from the review show that the ratio of reserves to production is 36 to 1. Crude oil production advanced from the 1955 total of 789 million tons to 857 million tons in 1956, with the Western Hemisphere accounting for 65 per cent and the principal producing areas being : U.S.A., 380 million tons ; Middle East, 170 million tons ; Carribbean, 136 million tons, and Russia 83 million tons. According to the review world consumption increased by 8½ per cent to a total of 851 million tons, of which the Western and Eastern Hemispheres consumed 531 million and 320 million tons respectively, or 62 and 38 expressed as a percentage.

The supply and demand balances, excluding Russia, given in the review, indicate that the U.S.A. had net imports of 51,000,000 tons in 1956 and that the Eastern Hemisphere received net imports of 22,000,000 tons from the Western Hemisphere. In the field of international trade exports totalled 324 million tons, including 120 million tons from the Caribbean and 155 million tons from the Middle East, while balancing import totals show that Western Europe took the major share with 129 million tons, followed by U.S.A. with 71,000,000 tons. World refining capacity advanced from 830 million to 905 million tons in the twelve months from the end of 1955 and of the 1956 total the U.S.A. was responsible for 450 million tons, the respective figures for Western Europe, Russia and Eastern Europe being 127 million and 90,000,000 tons respectively. During 1956 the deadweight of the world tanker fleet increased by 3,400,000 tons to 44,400,000 tons, of which the U.S.A., the United Kingdom and Norway owned 18, 17½ and 14½ per cent respectively.

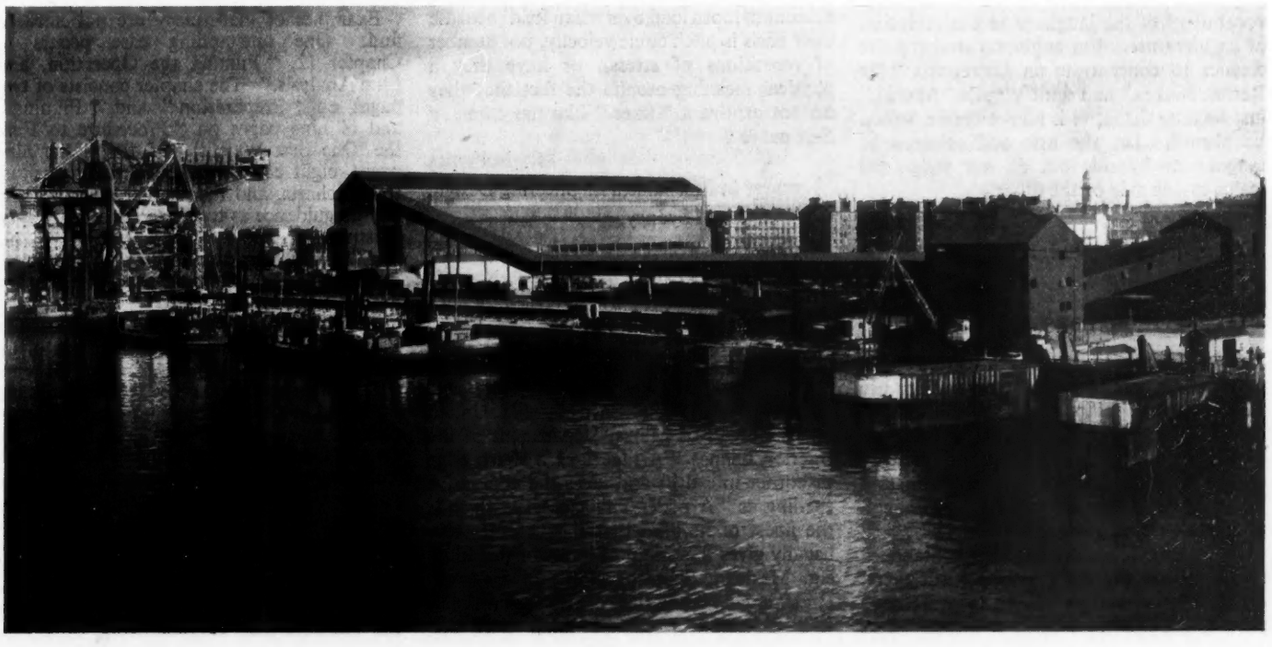
Ravenscraig Steel Works

A new iron and steel plant which has been built by Colvilles, Ltd., on a site at Ravenscraig, Motherwell, is now coming into operation. The site, which is over a square mile in area, is near to the company's Dalzell works and to the works of the Lanarkshire Steel Company (a member of the Colvilles group). The project was started in 1954, and the work completed includes a coke oven plant, a blast-furnace and a steel melting shop. The seventy coke ovens, in two batteries of thirty-five, have been built by the Woodall-Duckham Construction Company, Ltd. They are designed to carbonise 1600 tons of crushed coal a day, containing 10 per cent moisture. The ovens will yield approximately 620,000 cubic feet of gas an hour.

The upper illustration on this page is a general view of the Ravenscraig works, taken from the melting shop. The blast-furnace, built by Ashmore, Benson, Pease and Co., has a hearth diameter of 25ft 9in, and its rated output is 1000 tons of iron a day. About 6000 gallons of water a minute are circulated to the blast-furnace and the stove valves. Some of the return is bled to meet the process and cooling requirements of the sinter plant, for pig quenching at the casting machines and for make-up to the gas plant. The furnace is equipped with double charging skips, each of 220 cubic feet capacity, which deliver to a rotary distributor. The ancillary equipment includes a gas cleaning plant and a single strand sintering machine, designed for a maximum output of 10,000 tons of finished sinter a week.



The second illustration shows the melting shop building. It is equipped with 800-ton inactive mixers and 200-ton fixed open-hearth furnaces to give an output initially of 400,000 tons of ingots a year. The furnaces, which are water cooled, are fired with a combination of coke oven gas and liquid fuel. Consequent upon the building of the Ravenscraig plant, a considerable amount of work has been done at the General Terminus Quay, on the south bank of the Clyde at Glasgow, to enable it to be used solely for ore unloading. The ore handling equipment now installed is illustrated below. Unloaders transfer ore from the ships to a system of conveyors which, in turn, discharge into super-elevated storage bunkers. There are adequate sidings at the quay for marshalling the 34½ tons capacity ore wagons which are used on a direct rail service to Ravenscraig and to the Clyde iron works



LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

CAMBRIDGE ARTS AND SCIENCE DEGREE

SIR,—Your leading article on the proposed degree course in Arts and Science at Cambridge is timely. At a recent conference of the British Association on the supply of scientists and technologists for industry, favourable mention was made of the proposed new course and of a similar experiment being carried out at the University College of North Staffordshire as creating additional sources of scientific manpower.

Your article expressed the doubt whether such a course would be of direct interest to engineers other than in providing a supply of men of directorial ability, some of whom might find their way into engineering. Surely this does less than justice to the value of an education in the arts. As a scholar of classics who turned at the eleventh hour to engineering I realise that an arts education may put an engineer at an initial disadvantage with his contemporaries whose studies have always been in scientific subjects. If, however, education is taken as meaning learning how to learn rather than the acquisition of facts, this disparity in technical knowledge is of less significance. In quite a short time the gap is closed.

You make one other dangerous statement when you suggest that the arts portion of the proposed Cambridge course should have a bias towards science, mentioning as an example the value of a study of the history of British technology over the past 200 years. I hope that Cambridge will disregard your advice. If the study of a modern language were to form part of the arts course it would be valueless to concentrate on the technical vocabulary of the language to the exclusion of its literature. For engineers studying the classics to concentrate on Lucretius's "De Rerum Natura" and omit Virgil's "Aeneid," just because the latter is non-scientific, would be absurd. Let the arts and sciences be taught side by side but do not weigh the scales to one side or the other.

D. A. OGILVIE

Peterborough, July 10, 1957.

SPEED FACTORS FOR GEARS

SIR,—I should like to draw attention to the close connection between the revolutions per minute speed factor $n^{-0.2}$ given by Dr. H. E. Merritt in the third edition (1954) of his book, *Gears*, and the speed factors used by different manufacturers of rolling bearings. I believe this has not yet been noted, although their similarity is obvious.

As is known, successive British Standard speed factors for resistance to pitting and other types of surface failure in gears have steadily approached a curve $X=n^{-0.2}$, which offers an explanation for the empirical British Standard index 0·8 to the relative radius of curvature. Because tooth inaccuracies produce dynamic loading, speed factors based on revolutions per minute have to be coupled to a device allowing for the increase in pitch circle velocity with increasing pitch diameter. The expression for the (not B.S.) load-carrying capacity of gears for "wear" may therefore be written as $P_1=Q_1\ n^{-0.2}$ where Q_1 embodies a stress factor, the face width and the relative radius of curvature, the latter with an index 0·8. It follows that $n=(Q_1/P_1)^5$ which is the maximum permissible revolutions per minute for a given running life and given magnitudes of Q_1 and P_1. The magnitude of Q_1, when referred to B.S. practice, is also the permissible load for a running life of 1,560,000 revolutions.

The bearing intensity between two cylinders with axes parallel according to Hertz is $p \propto P_1^{\frac{1}{2}}$. Between spheres or between a sphere and a toroidal surface (ball bearing) it is $p \propto P_2^{\frac{1}{3}}$, and possibly also in all cases where the area of indentation has an elliptical shape. For a given bearing intensity, therefore, $P_1 \propto P_2^{\frac{2}{3}}$, assuming a fixed magnitude of the relative radius of curvature. Substitution gives $n=(Q_2/P_2)^{3.33}$. Ignoring Hertz's ideal assumptions, this then would apply to ball bearings.

S.K.F. practice is based on a running life of $(C/P)^3$ millions of revolutions, C being the "basic dynamic capacity" and the permissible load for a (S.K.F.) running life of 1,000,000 revolutions. The same index seems to be used by Hoffmann, whereas General Motors and Timken use indices of 4 and 3·33, respectively. From the foregoing these values seem plausible enough, also in cases of roller bearings when a slight skewing of the rollers is assumed. The question, however, is: are speed factors for gears to be regarded as a device primarily allowing for the excess of maximum tooth load over mean load (because their basis is pitch circle velocity, not number of repetitions of stress), or have they a physical meaning despite the fact that they do not exhibit a "knee" like the common S–N curve?

M. BOOMSMA

Lecturer in Mechanical Engineering Design,
University of Sydney,
N.S.W.,
July 17, 1957.

ARRIS AND ARRIDGE

SIR,—The *Glossary of the Mining and Mineral Industry* published by the United States Bureau of Mines, Department of the Interior, defines "Arrage" as a sharp edge or corner in a drift and gives the alternative spelling as "Arris." This glossary, which is the finest of its kind that I have ever seen, usually gives the origin of terms of this kind, e.g. Mexican, Spanish, North of England, Russian, &c., but in this case no such association is cited. I cannot think that Mr. Stevenson is right in associating the term with the North of England, as I have worked in both metalliferous and coal mines in Cumberland, Northumberland and Durham, and have never heard the term used.

I would suggest that the word is derived from the Swiss "arête"—a sharp ridge or rocky edge—which, in turn, comes from the Latin *arista*, a fishbone or spine.

H. STOREY

Mine and Quarry Engineering,
33, Tothill Street,
London, S.W.1.
July 25, 1957.

Book Reviews

Motion Economy and Work Measurement. By R. L. MORROW. Second edition. The Ronald Press Company, 15, East 26th Street, New York 10, N.Y. Price 7.50 dollars.

THIS is a second edition of *Time Study and Motion Economy* with a title changed to indicate an increased emphasis upon the "motion economy" side of work study. Such a change in emphasis is welcome, as is also the inclusion of new material which is described in the following terms:—"This edition includes many new subjects, such as the application of motion economy to office work, complete coverage of micromotion study and the equipment used, the taking of motion pictures of operations and the analysis of the film for motion economies and organisation for methods improvement. . . . Work sampling, formerly called ratio-delay, is fully covered and there are examples of its many uses. New material on fatigue measurement has been included, . . . &c." All this makes for a better-balanced and more comprehensive book. But, unfortunately, much of the new material is open to criticism because it is inadequate, because it is often badly arranged and even, sometimes, because it is inconsistent or inaccurate.

Examples of inadequacy are not hard to find. One outstanding case occurs in Chapter 12, "Filming the Operation, and Film Analysis." The chapter consists of two pages on "Preparation" and "Filming" and of nine pages on "Procedure to Find the 'One Best Way.'" Of these latter nine pages, eight consist almost entirely of illustrative charts, and the chapter gives practically no guidance as to how a simo-chart must be studied to find the "one best way." This can hardly be described as "complete coverage of . . . the analysis of the film for motion economies."

The chapter on "Measurement of Muscular Fatigue" consists entirely of a précis of an eleven-page article by Dr. Lucien Brouha, dealing with heart-rate recovery after fatiguing work and in different heat and humidity conditions. We are told in a footnote "all quoted material in this chapter is from the same source unless otherwise indicated." The chapter indicates no other sources. Important and interesting as Dr. Brouha's work may be, a chapter claiming to deal with "measurement of muscular fatigue" is hardly adequate if it rests upon a single article. Such a chapter should either quote the author's own original work or survey

research in general upon the problems with which it claims to deal. Failing that it would be better to refer students to some such survey and leave it at that. Perhaps the outstanding example of inadequacy occurs on page 194, where there are seven lines under the heading "Length of Study." These ignore all that is known about the problems of sampling and all the well-established formulæ for deciding how many cycles should be timed to achieve an accuracy within specified limits. The lines read as follows: "No definite rule can be made for the length of the time study. When cycles are short, many observations are obtained in a short time and the study need not be long; when cycles are long, the study must be of greater length. When there are variations caused by operator, work or conditions, more cycles should be observed. Two short studies, taken at different times, are better than one long study." This is naive and contrasts sharply with the treatment of this matter in most textbooks, American and British.

The general arrangement of the book is not always logical. For example, the preface refers to "work sampling, formerly called ratio-delay," thus implying that these two terms are synonymous. Nevertheless, we find separate chapters, one called "The Ratio-Delay Study" and the other "Work Sampling." These surely ought, both on general grounds and for consistency with the preface, to be combined. Moreover, the arrangement of the material within these two chapters is confusing. Statements of general statistical theory and descriptions of case applications are mixed together in such a way that we doubt whether any reader, coming new to this subject, could possibly hope to understand the general statistical basis of work sampling or the detailed applications. These chapters should be completely reorganised, whenever a further edition of the book is issued.

Inconsistencies, both major and minor, are common. One which is annoying, though not basically important, is that the main title uses the term "Work Measurement," but the book refers throughout to "Time Study." Another small, but irritating, example is that on page 118 we are told that "a 16mm motion picture camera should be used," but three pages later we find "usually a 16mm (sometimes an 8mm) projector is used." This is perhaps a small matter—it should have been picked up in proof reading—but it is very confusing for the reader. The major and most important inconsistency, however, occurs in the several discussions of "the one best way" and of the general problem of finding the most efficient methods of work. At the beginning of Chapter 3, a definition of time study is given which includes "development in practical detail of the best manner of doing (a piece of work)." A similar claim is made on pages 185–6. However, later (Chapter II, page 130), we are told that "the simo-motion chart is the key to the 'one best way.'" Yet again, on page 386, in summing up the two chapters on "Motion Time Standards," we find: "Actually, the best method can be worked out in advance, the operators can be shown the best method and the foreman or engineer can follow up to see that the operation is done as planned. This was the original use for motion time standards and it continues to be its most valuable application in determining the 'one best way.'" Thus separate claims to the same laurels are made for time-study, micromotion study and motion time standards. This is, to say the least, inconsistent.

Throughout, the book is unsatisfactory wherever statistical techniques or concepts arise. One example, on page 194, has already been quoted. Others are not difficult to find. On page 242, it is recommended that the mode should be used and not the median. Since the latter has all the virtues (*sic*) of the mode, is nearer to the true arithmetic mean and is easy to calculate, this advice is contrary to the best statistical practice. On page 275 we find the following: "In these applications, the conditions of statistical control are probably not accurately met; however, by making an empirical application it is possible to try for objective measurements and progressive refinement. Tests for conformity to the binomial law will consist of seeing how the actual and theoretical variations, added together, compare with the random errors of observation." The phrase "try for objective measurements" is meaningless in this context and there are no statistical tests in which actual and theoretical variations are added together. Again, on page 311 there is a reference to tests of "goodness of fit" when what *are* meant are the well-known formulæ for the standard error of a percentage or proportion.

The book is sound enough where it is concerned with time-study techniques and motion-time standards, and it can be recommended to those primarily interested in these subjects.

System Engineering. By H. H. GOODE and R. E. MACHOL. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 75s.

DURING the past ten years the design of large-scale engineering systems has been influenced profoundly by the findings of research workers in many fields and by advances in production engineering. And the term "system engineering" has been coined to describe the processes of planning and programming which precede the fabrication of a system. In this context, large-scale systems are assumed to include, for example, analogue and digital computers, data processing systems, &c. An important factor of system engineering is the integration into present-day design techniques of such comparatively new analytical procedures as information theory, linear and non-linear programming, queueing theory, games theory and cybernetics. Although most of the material has been published elsewhere the present volume by two well-known authorities in the field will be warmly welcomed, since it is the first full-scale work on the subject. Perhaps a more appropriate title might have been "Some Methods of Operational Research," because the emphasis of the book is essentially operational rather than technological and the sole intention appears to be to introduce the reader to the analytical methods mentioned above without, at the same time, giving the appropriate engineering applications. The material is presented in five main parts which deal respectively with:

(i) Examples of large-scale systems and the concept of integrated design.

(ii) An introduction to the theory of probability and the analysis of experiments.

(iii) The so-called "exterior" design of a system in which environment is studied through the applications of probability theory.

(iv) An introduction to analogue and digital computers.

(v) Basic analytical design techniques with special reference to control and communication.

Distinction between so-called exterior system design and interior system design is made; for example, factors extraneous to the physical system, such as the study of the basic system requirements and related statistics, are regarded as "exterior" as opposed to "interior design" considerations, which concern the specific design of the system to satisfy the given requirements. The prime objects of the book are, first, to familiarise the reader with the language and tools of system engineering, and, secondly, to stimulate him into further reading in connection with specialised aspects of the subject; it is not intended to act in any way as a designer's "guide book." These general objectives are clearly worthwhile in these days of increasing specialisation, although we feel that more discrimination in the choice of topics might have been profitable. For example, the excessively brief treatment of computers is quite inadequate to give the uninitiated even an elementary idea of design principles and applications, and likewise the chapter on simulators would not materially assist, for example, the designer of a nuclear power station.

The book lacks organisation in some respects and might have been reduced in size and scope without unduly decreasing its worth. For example, servo-mechanism theory is introduced in two distinct chapters completely dissociated from each other and the same applies to simulation. The related subject of cybernetics is rather academic and in its present form would not be of much use to the practising systems engineer. On the other hand, in a book of the present magnitude and scope, the first of its kind in the field, it would be quite impossible to please everybody, and the authors have made an admirable attempt to do so. Of special note are the following chapters:—Chapters 1–3, on the "nature of the problem"; Chapters 21–24, in which the basic concepts of queueing theory, games theory and servo-mechanisms theory are introduced; Chapter 30, which discusses the problem of designing control systems in which human operators form an integral part; and the final chapter, which deals with some of the problems of management. These and several other chapters are well written and will prove useful to designers who are interested in large-scale development programmes.

The book is well presented and illustrated It is recommended to engineers as a sound introduction to some of the more sophisticated analytical procedures, arising in system engineering, which will have an increasingly important influence on engineering design in the future.

Books Received

The Diesel Locomotive. By R. L. Aston. Thames and Hudson, Ltd., 30, Bloomsbury Street, London, W.C.1. Price 12s. 6d.

Surveying. Second edition. By Charles B. Breed. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 44s.

Directory of Opportunities for School Leavers 1957. Cornmarket Press, Ltd., 1, Lower James Street, London, W.1. Price 8s. 6d.

Combustion Researches and Reviews, 1957. Butterworth's Scientific Publications, Ltd., 88, Kingsway, London, W.C.2. Price 40s.

Automation in Business and Industry. By Eugene M. Grabbe. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 80s.

Industrieofenbau. By J. Henri Brunklaus. Vulkan-Verlag Dr. W. Classen, Haus der Technik, Hollestrasse 1g, Essen. Price DM.46.

Magnesium Casting Technology. By A. W. Brace and J. A. Allen. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 21s.

Technical Drawing. By W. Abbott. Part One: Introductory. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 7s. 6d.

Mechanical Vibrations. By Bernard Morrill. The Ronald Press Company, 15, East Twenty-Sixth Street, New York, 10, N.Y. Price 6.50 dollars.

Reconstruction in the North Staffordshire Coalfield*

By R. W. SCURFIELD, B.Sc.

THE importance of the North Staffordshire Coalfield in the plan for future coal mining in Great Britain is due to the extent of reserves of high quality coal in the area and, in particular, to the fact that a considerable proportion of the reserves is suitable for carbonisation.

Briefly described, the coalfield is in the form of a triangular syncline, with a north-south axis pitching southwards with highly inclined western and eastern flanks. The active and proved area of the coalfield is some 85 square miles. The total thickness of the productive coal measures in North Staffordshire is over 1500 yards. In the middle of the syncline the productive beds are overlain by the upper non-productive measures. As would be expected with a structure of this nature, the coalfield is divided up by a considerable number of large faults. In addition, the degree of minor faulting is substantial in certain parts of the coalfield. In the area now being exploited the full dip at the coal face varies from 1 in 1·8 to level, though the average is about 1 in 4·5.

It is estimated that the total reserves of all types of coal down to a depth of 1300 yards amount to 1400 million tons. Of these, over half are in carbonising seams lying between 900 yards and 1300 yards. The greater part of the more valuable reserves of carbonising coal all lie below 1000 yards.

The coalfield is one of the richest in Western Europe. The superficial area may not be great but the density of coal is very high. The average number of workable coal seams in the series over the coalfield is twenty-five, with a total coal thickness of 100ft.

The output from the collieries in the North Staffordshire area in 1956 was 6,136,284 tons, in addition to which small mines contributed a further 277,725 tons.

The coalfield underlies the five towns of the Potteries and the borough of Newcastle under Lyme. These comprise a most compact industrial area with a population of 344,000. The subsidence problem has a very considerable influence on the plans for reconstruction and operation of the coalfield.

Problems of the Coalfield

The major mining problems of the coalfield, in addition to that of subsidence, are those associated with depth. With deep workings, getting a shift of men from the surface to the coal face and back again at change of shifts in the minimum time possible is of extreme importance. Minutes lost in travelling time with a shift of 1200 to 1500 men are very expensive.

The virgin rock temperature at 900 yards deep is approximately 95 deg. Fah., and at 1300 yards it is 115 deg. Fah. A considerable proportion of the workings in the area are below 900 yards deep, and the proportion is steadily increasing. The deepest workings in the coalfield have already reached 1300 yards. Certainly one of the major problems of the coalfield is to find means of maintaining satisfactory atmospheric conditions at the working face at a depth of 1100 yards and below.

Gas emission is high. The rate of emission varies substantially from one seam to another and from one coal face to another, according to conditions, but emissions of over 2000 cubic feet per ton of output have been recorded; 800 cubic feet per ton is common in the deeper seams.

Dust is a most serious problem. The workings at depth are all relatively dry and the deeper seams are comparatively friable. Means for overcoming the dust menace have to be borne in mind in connection with all mining operations. Spontaneous combustion is associated with a number of seams in the series.

Compared with the figure for the country as a whole, the coal face productivity is high. The degree of mechanisation at the end of 1956 was over 20 per cent. Face mechanisation will increase still further in the near future, and it will be surprising if the figure for 1960 does not exceed 50 per cent.

The shifts per 100 tons show that the "Transport" and "Surface" categories need urgent attention. The reconstruction of the coalfield must bring about a radical improvement in the efficiency of these two categories. The low transport efficiency will be readily understood when it is realised that at almost every colliery in the coalfield the majority of producing faces are at a level well below that of the pit bottom—as much as 300 yards in some cases. Costly dip haulage systems have to be operated to maintain production, and these systems are continually extending as reserves are worked out.

For a variety of reasons the surface efficiency is low. At a number of collieries coal preparation plants intended to prepare the best seams are now being operated in an attempt to prepare the lower quality seams. Electrification has not been adopted extensively up to now, for a number of reasons—possibly the most important being the difficulty of designing a satisfactory electric winder for winding comparatively light loads associated with tub winding in comparatively small deep shafts. Many of the collieries suffer from antiquated surface layouts which have been in operation for many years. The power, heat and light cost for the area in 1956 averaged 6s. 5·1d. per ton.

The national importance of the coalfield is due to its reserves of carbonising coal. Under the national plan the area output capacity is to be increased to 9,000,000 tons per annum by 1968. The actual figure in 1956 was 6,136,284 tons. Thus the reconstruction programme has to provide for a 50 per cent expansion of output in addition to replacement.

The programme includes six major schemes of reconstruction—four with an annual capacity of 1,250,000 tons, one for 1,500,000 tons and one proposed combined mine with a capacity of 2,000,000 tons. The proposed annual capacity of these six reconstructions is 8,500,000 tons out of the area's total of 9,000,000 tons by 1968.

Requirements of Reconstruction Plan

To provide an adequate solution for the future of the North Staffordshire coalfield the reconstruction plan has to fufil six basic requirements. These are to provide for :—

(i) The increase in area output capacity from 6,000,000 tons per annum to 9,000,000 tons per annum by 1968.

(ii) Satisfactory ventilation for the working of the many millions of tons of first-grade carbonising coal lying between 900 yards and 1300 yards.

(iii) Means whereby solid stowing can be applied anywhere within the working coalfield where its application is indicated in order to minimise subsidence damage.

(iv) Rapid and efficient transport of men and materials from the surface to the coal face.

(v) An efficient system of coal transport from the coal face to the railway wagon or road vehicle.

(vi) Facilities for the proper preparation of the output for the market.

The basic requirements of the North Staffordshire plan can best be met by four main developments. The first is the sinking of shafts down to a depth below that of the lowest workings. The second is the adoption of level main haulage systems so that all coal and stone and stowing dirt are transported in mine cars on level roads by locomotive haulage, with conveyor transport between the face and the mine car on the level.

The third is the introduction of horizon mining so that each district of the colliery is served by two level haulage systems, the lower one on which the coal is hauled and the upper one which is largely used for stowing dirt and materials transport. The concentration of seams in North Staffordshire is such that at most of the large collieries one top ventilation and stowing horizon and two production horizons, with a fourth horizon in development, will always be necessary if output is to be maintained.

The fourth is the introduction of cage and balance weight winding as the essential complement to multi-level horizon mining.

The shaft sinking programme for the area is considerable. Since vesting date one 24ft diameter shaft has been completed to 1136 yards; one shaft has been deepened from 750 yards to 1100 yards; one 12ft 6in diameter shaft, 856 yards deep, is in process of being widened to 20ft; and one 16ft diameter shaft is now being deepened. Shaft sinking preparations for another 24ft diameter shaft, 1150 yards deep, have been started.

The shaft sinking to be carried out in the next ten years includes five new 24ft diameter shafts, all of which will be between 1050 yards and 1150 yards deep in the first instance. In addition, there will be three major deepenings of existing shafts.

The eventual depth of most of these new shafts will extend to 1300 yards. The shafts will be equipped with winders designed to operate from this depth.

Level Haulage and Horizon Mining

From the description of the geological structure of the coalfield it will be clear that no system of main coal haulage in the seams, be it on ropes or conveyors, is likely to remain efficient over many years. Initially results may be most satisfactory, but after a time with continual extensions, inevitably to the dip and across faults, the system must become uneconomic.

The only system which provides a satisfactory long-term solution to the coal haulage problem in North Staffordshire is that based on level main haulage roads, driven for the most part in stone to which are linked conveyor systems in subsidiary seam roads, inclined stone roads or staple shafts. With such a level main haulage, mine cars and locomotives provide the maximum flexibility and efficiency.

When the colliery reconstruction schemes now envisaged for North Staffordshire are in full production, the underground haulage systems will be required to deal with the transport of upwards of 3,000,000 tons per annum of stowing dirt from the surface to the working face.

For the consistent operation of solid stowing on any coal face, it is of the greatest importance that the stowing system should be independent of coal filling. It is equally important that the coal and stowing dirt transport systems should not be dependent one on another. With coal transport at the lower horizon and stowing dirt at the upper, this separation is achieved on the locomotive systems underground. It is equally important that the independence of the two systems should extend right through to the coal preparation plant and the dirt preparation plant.

In most of the reconstructions one shaft is being reserved for coal winding and one for stone, stowing dirt and materials. The separation will be made in the pit bottom. In most cases there are to be two winders on coal continuously and one on stone and stowing dirt. The surface circuits will normally be separate, but facilities will be provided so that occasional cars of stone wound with the coal can be diverted out of the coal circuit and taken to the stone tippler, and vice versa.

Cage and Balance-Weight Winding

As a means of winding from considerable depths, the cage and balance-weight winding system appears at first sight to be totally unsuitable. Compared with the usual two-cage system to wind a given output from one level, with cage and balance weight either the winding cycle has to be halved or the payload doubled. The former is impracticable, due to excessive acceleration and shaft speeds, so the latter solution has to be adopted. As a result, the size and first cost of the winding equipment is increased substantially. The power cost per ton of mineral raised is, strangely enough, hardly affected. There have to be very good reasons for adopting

* Abstracts from a paper presented to the annual general meeting of the Institution of Mining Engineers, July 24.

the cage and balance-weight winding system to justify this additional first cost.

A standard cage and balance-weight winder is being adopted for North Staffordshire. This winder is designed to raise 240 tons per hour from 1200 yards in 2½-ton mine cars, with a payload of 20 tons and a balance weight of 35 tons. The winder is being designed to raise the same payload from 1300 yards. The winder will be a multi-rope friction type with a 16ft drum, using four 1¾in locked coil ropes, with a single direct-coupled, 3300 h.p. motor, using the Ward-Leonard system.

Considerable thought has been given to evolving a pit top circuit suitable for the new shafts with the two cage and balance-weight winders. In the pit top layout which is to be adopted at the double winder cage and balance-weight coal shafts a very simple turntable circuit is provided for each cage, and each circuit operates independently of the other. Provision is made for turning out any cars of stone wound with the coal at the fulls turntable. Similarly, if it is necessary to introduce empties or materials, provision for this is made at the empty turntable.

In most cases the coal wound at the shaft may be either general purpose or cabonising, and provision is made to separate these coals at the tippler. A simple change-over chute has been designed for this purpose which should be almost foolproof and reduces the extent of the feeder conveyors beneath the tipplers to a minimum.

Ventilation

The ventilation of the deep workings in North Staffordshire presents two major problems. The workings have to be adequately ventilated to keep the methane content of the air within permissible limits, and, at the same time, reasonable climatic conditions for men working underground have to be maintained.

The quantities of air to be passed in the shafts of the reconstructed pits are considerable. For a colliery with a saleable output from the deeper seams of 5000 tons per day, it is expected that a quantity of some 800,000 to 900,000 cubic feet per minute will be required at the fan. With the horizon layout envisaged for these collieries, a water gauge of 15in to 20in will be necessary.

To pass 800,000 cubic feet per minute through a 24ft diameter shaft necessitates a shaft air velocity of nearly 2000ft per minute, and any advantages which can be got from shaft layout to reduce ventilation pressure drop in the shaft will be taken. The cage and balance-weight arrangements for two winders in the 24ft diameter shaft with two long cages on rigid guides and the balance weights on ropes, will give a shaft layout with a comparatively low ventilation resistance. The more normal shaft layout for a four-cage arrangement with rigid guides is not so satisfactory. Streamlined fairings of the buntons will be considered.

Standardisation

It will not be possible to complete the reconstruction programme for North Staffordshire within the ten years unless a considerable degree of standardisation is adopted. Apart from any other advantages to be got from standardisation, staff shortages will make it essential. The first two major schemes for the coalfield are now well advanced, and there was neither the experience nor the time available to standardise layouts or equipment before the first phases of each of these reconstructions had to be planned and settled. Fortunately, it has now been possible to introduce some elements of standardisation in the later schemes.

After considerable investigation it has been found that most of the new electric winders required for the major reconstructions fall into two categories. Within the next ten years eight to ten four-rope friction winders will have to be installed. The second standard winder will be normally for service shaft duty and will be somewhat similar, but with a 14ft drum and a 3000 h.p. motor. In the same period, five of these winders will have to be installed.

The standard pit top circuit will be used for four, possibly five, of the new shafts. The design of stowing dirt preparation plant will also be standardised.

Atomic Energy Authority's Report

THE third annual report of the U.K. Atomic Energy Authority has been presented to Parliament. Several important developments are mentioned. Particular attention is drawn to the opening of Calder Hall* by Her Majesty the Queen on October 17, 1956. At a conference on the day of presentation of the report to Parliament, Sir Christopher Hinton was asked what snags had been met at Calder Hall. He replied that this was the dullest process plant he had ever had to deal with; the only teething troubles he mentioned were the unexpectedly high leakage of carbon dioxide and the effects of creep in fuel elements. He emphasised that Calder Hall was optimised for plutonium production, and that electric power was merely a by-product. Cost figures for power generation were therefore misleading.

The report refers to collaboration with the Admiralty in planning the land-based prototype of a submarine reactor, to be built at Dounreay. The design for this pressurised-water reactor is in the hands of the Vickers/Rolls-Royce/Foster Wheeler group, but the Authority is responsible for the physics of the system, the production of fuel elements, corrosion studies, component testing and shielding investigations. The technology is quite different from that of a gas-cooled reactor. Enriched uranium fuel elements are to be used, and good progress is reported in their development. Representatives of the Authority serve on the Admiralty Committee considering nuclear power for the propulsion of merchant ships. Nuclear fuel costs well below the current price of oil (halfpenny per shaft horsepower-hour) are expected in the large graphite-moderated, gas-cooled power station installations, and it is thought that the bigger ships such as tankers could use a reactor on the lines of Calder Hall. New systems need to be developed for smaller ships, however. Power units of the kind being considered for marine use may also turn out to be suitable for the export market, a large part of the demand being for units of about 30MW.

Harwell has continued its search for ways of controlling thermo-nuclear reactions. The problem is to heat hydrogen isotopes to 100 million deg. Cent. (at which temperature separate nuclei fuse into single heavier nuclei and release energy) while isolating the gas from the walls of the container. This very high temperature must be sustained long enough for the energy output to exceed the input.

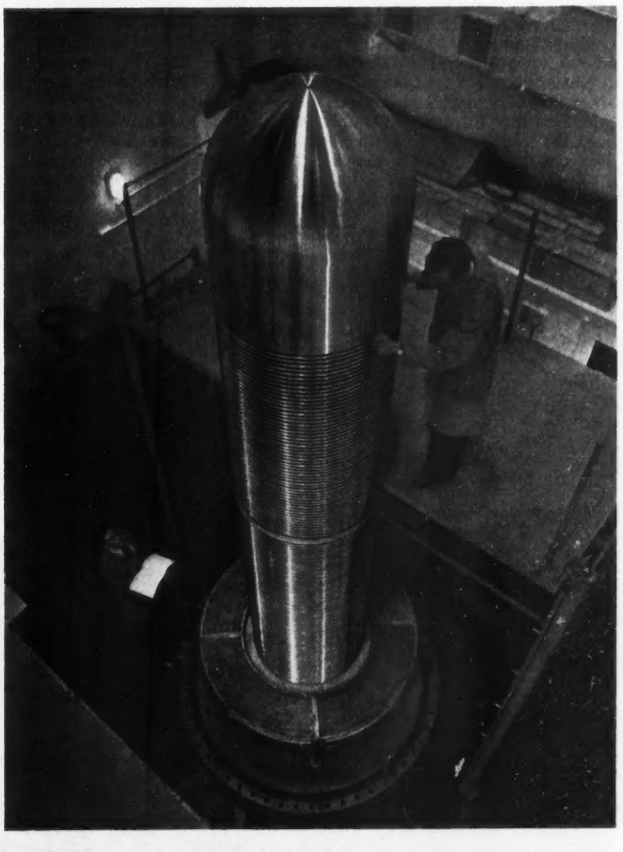
Three new reactors, LIDO,† DIDO‡ and NERO,§ were put into commission at Harwell during 1956–57. The first is a 100kW "swimming pool" reactor for work on shielding, particularly of the lighter kind needed for ships. DIDO is a 10MW high-flux reactor for testing moderator materials, coolants and fuels. The physics of more advanced graphite-moderated reactors, cooled either by gas or liquid metal, is studied in NERO. The greater part of Harwell's work is devoted to reactor technology.

The gas-cooled graphite-moderated reactor principle has improved on acquaintance more than had been thought likely; the Authority is not now confident that the sodium-graphite system is advantageous enough to build a prototype reactor. By using uranium oxide ceramic fuels and beryllium canning it is hoped to raise the operating temperature of the fuel elements in the gas-cooled reactor from 400 deg. to 600 deg. Cent. In this way the output of a two-reactor power station could be increased from 300MW to 800MW.

Intensive work is proceeding on a thermal breeder reactor operating on the uranium-233/thorium cycle; here fissile uranium-233 is burned in the core, and released neutrons produce more uranium-233 by transmutation of thorium. Ceramic uncanned fuel is required, able to withstand temperatures up to 800 deg. Cent.

Sales of radio-isotopes increased by 12 per cent during the year, amounting to about £541,000. Exports went to fifty-two countries. New applications of specific isotopes continue to be found. Pebble movements on beaches and under coastal waters have been traced, a cheap method for the continuous determination of sulphur and lead contamination in hydrocarbon oil processing has been developed, tracers have been used to measure throughput, hold-up and recirculation in cement and fertiliser plants, and such devices as liquid-level indicators and soil density meters have been produced.

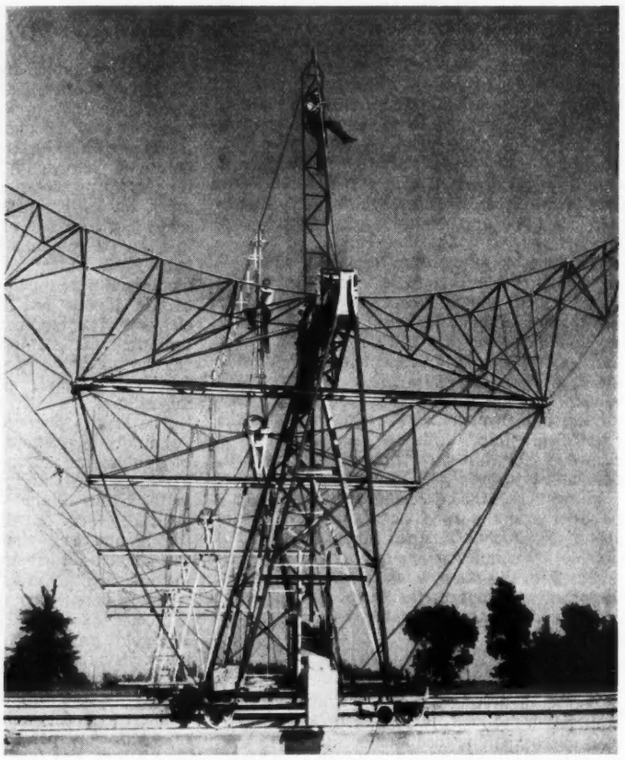
The great activity of the Weapons Group is, of course, common knowledge, and it is reported that all promised dates have been met successfully. Two important research facilities have come into operation during the year, a Van der Graaf accelerator (see illustration) and a large computer. In the Van der Graaf machine a continuous non-conducting belt carries an electrostatic charge from the base to the polished dome at the top. The potential on the dome can be built up to 6,000,000V. The final potential can be kept constant within ±1kV, and is used to accelerate beams of particles to high energies, the ions themselves being produced inside the dome and accelerated down through the column into the room below.



6,000,000-volt Van Der Graaf high-voltage electrostatic generator at Aldermaston. The constant energy beams of particles produced in the generator are used to bombard different materials, to initiate nuclear reactions, and so to obtain a better understanding of atomic nuclei.

* THE ENGINEER, October 5, 12 and 19, 1956.
† THE ENGINEER May 4, 1956.
‡ THE ENGINEER, December 7, 1956.
§ THE ENGINEER, March 29, 1957.

Radio Observatory



Sir Edward Appleton opened, on Thursday last week, the Mullard Radio Astronomy Observatory of the Cavendish Laboratory, Cambridge. The open rural site includes two large aperture synthesis aerial systems, and the moving element of one for the study of radio stars is shown here. It obtains high resolution by use of the interferometer principle. The rails seen are not horizontal but truly straight throughout their length of 1000 *ft.*

IMPORTANT work in radio-astronomy was started soon after the war, both in Cambridge, under Mr. Martin Ryle, and in Manchester, under Professor A. C. B. Lovell.* Mr. Ryle, at Cambridge, began the development of special types of radio telescopes which have been used for detecting the astronomical bodies known as " radio-stars," and for investigation of the sun. Even this earlier work made possible the detection and measurement of almost 2000 radio stars, and the results suggested that many of these might be at greater distances than the most remote objects observable with optical telescopes.

In 1955 the University of Cambridge received from the Mullard company an offer to provide, over a period of ten years, the sum of £100,000 for the purpose of continuing and extending the work in radio astronomy which is being done by the Cavendish Laboratory. Principally with this benefaction, a new observatory, to be known as The Mullard Radio Astronomy Observatory, has been established a few miles from Cambridge.

With the help of the Mullard benefaction, the Cavendish Laboratory has been able to acquire the site at Lord's Bridge and to erect on it a new radio telescope capable of investigating and observing radio stars far beyond the reach of the earlier instruments. It is expected, in fact, that the new telescope will enable observations to be made which have hitherto been impossible to achieve.

This telescope uses the principle of " aperture synthesis " to obtain high angular resolving power, the objects being sufficiently " bright " for a large aerial not to be needed to obtain an adequate signal-to-noise ratio. In this technique the reception pattern of a large aerial is built up by integration of the receptions of two small aerials which are moved in such a way as to cover, between them, the entire area. If the variation of the signal across the area is linear, this can be done by moving the aerials solely along two lines at right angles.

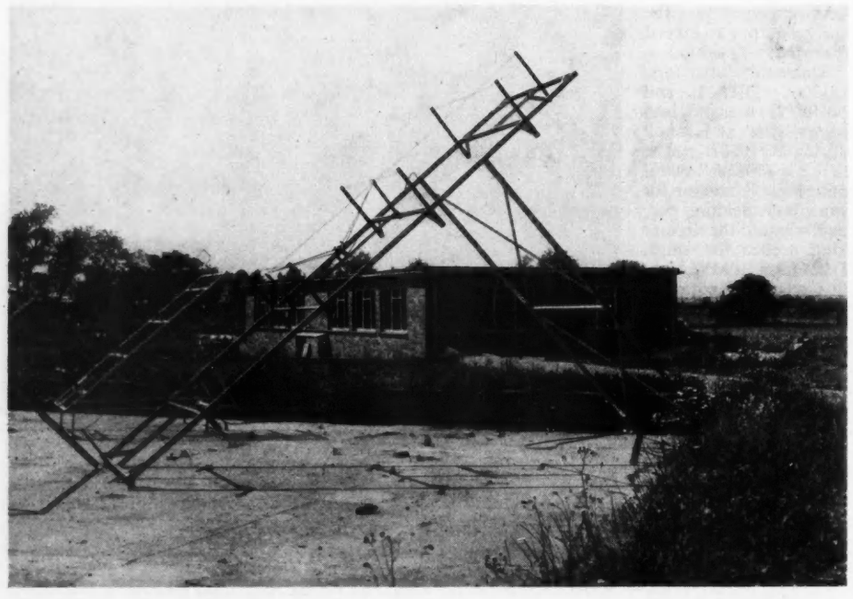
The area is covered completely when a line joining the two aerials have taken up all possible lengths and orientations within the area, and this may be achieved by moving them along two straight lines at right angles to one another. In practice one of these lines is completely filled by one long aerial array, and only on the other is a moving aerial used. The aerials are connected to a receiver, which measures their amplitude and relative phase. Addition of the records taking account of phase, can then produce the same record as would be obtained from a completely filled aperture.

The resolving power even of the large aerial that can be simulated by this method does not, however, satisfy the standards of accuracy in angular measurement required, and for this reason interferometry is invoked, two aerials being set up at a known distance and direction apart and the phase difference between their signals examined. In accordance with this principle, the track of the moving aerial does not cross the fixed aerial, as can be seen in the diagram. The method of operation is to set the moving aerial at one end of its track, incline both aerials to the desired angle of declination, and record incoming signals for twenty-four hours or until a satisfactory record is obtained : the moving aerial is then advanced 10ft and the process repeated. The technique may be briefly described by saying that the fixed aerial provides a standard for comparison of the signals received at various positions of the moving array : the accuracy required is such that the lengths of aerial feeders are controlled within 1cm. The operation of synthesising the observations is, of course, performed by a computing machine, the EDISAC being used.

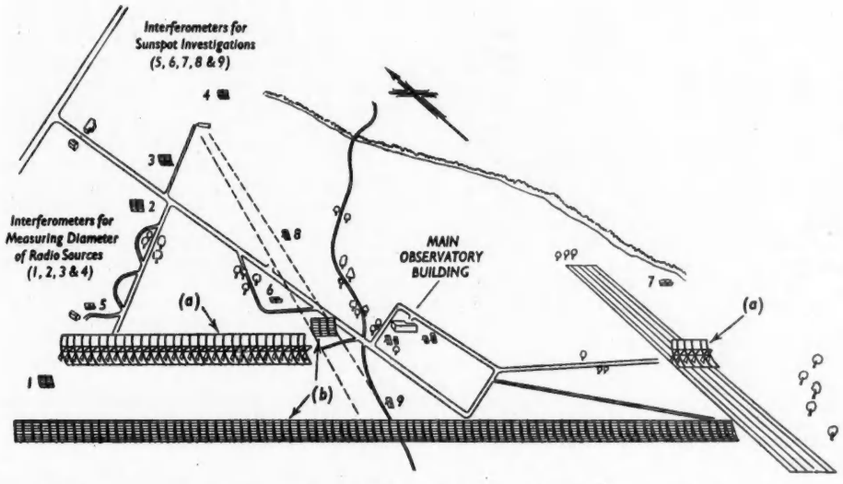
For the study of the radiation coming from intergalactic space, a second aerial system has been erected. This receives energy of wavelength 7·9m and has a " pencil " beam of 1 deg. by 1 deg. to half intensity : the moving aerial is sufficiently light to be portable and does not move on tracks. The dimensions of the array are considerably larger than for the radio-star interferometer.

There are also on the site several simpler aerial

* See THE ENGINEER, July 5, page 7.



Aerials used in the study of solar radiation are seen in front of the observatory building


Interferometers for Sunspot Investigations (5, 6, 7, 8 & 9)
Interferometers for Measuring Diameter of Radio Sources (1, 2, 3 & 4)
MAIN OBSERVATORY BUILDING
(a)
(b)

(a) Radio-star interferometer employing aperture synthesis. It has the same resolution as two aerials each of size 800ft by 500ft.

(b) Pencil beam instrument which uses aperature synthesis for investigation of galactic radio emission. It has the same resolution as a paraboloid 2000 feet in diameter.

Arrangement of aerials at Mullard observatory

systems which can have high resolving power by virtue of the area available on the site. In our illustration there can be seen, outside the observatory building, aerials for the reception of solar emissions.

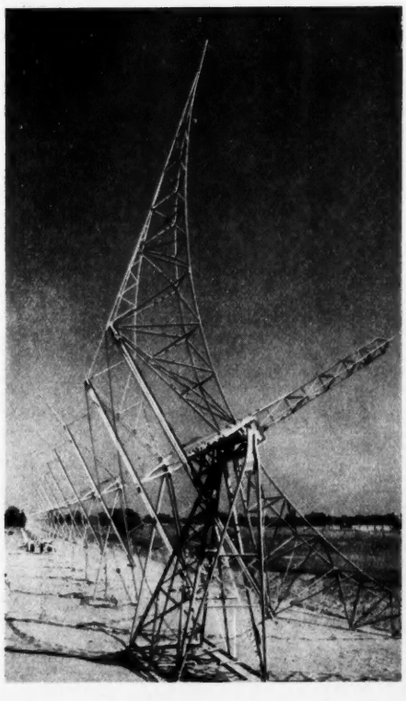
Aerial Construction

The radio-star aerial is tuned to 1·7m wavelength and has a parabolic section 65ft from tip to tip : the fixed section is 1450ft long and the moving section 190ft long. The fixed section stands on towers of zinc-sprayed steel angle, assembled with cadmium-plated bolts, and grouted into massive concrete foundations. The reflector is carried on welded frames of steel tubes, which can be swung 60 deg. on either side of the vertical. They are rotated by chains passing over indented pulleys, the bight of the chain being kept tight by a hanging weight, and each is moved by its own synchronous motor. The several frames are kept in phase by arranging the control gear so that each pulley moves one revolution at a time, the pulley having a cam on it to stop the motor : each step represents about 2 deg. change in declination. Fine adjustment is attained by stopping the movement in between these checks. The reflector is formed by galvanised steel wires at intervals of a few inches : the reflector is kept tight regardless of temperature by weights pulling the end frames outward, the intermediate ones being allowed to float. The tension is taken by bracing wires rather than the fine gauge wires actually forming the reflector.

The moving aerial runs on six rails, resting on piles driven into the underlying clay : it is noteworthy that these rails define a plane and do not conform to the curvature of the earth. (The departure from the horizontal is of the order of ¾in.) The outer pair at each side carry towers which have one degree of freedom only, movement along the rail : above each of the inner four rails is a tower which is free to move longitudinally and to roll. Each of the four separate towers is traversed by a synchronous motor and exact alignment is again preserved by stopping all motors at fixed intervals, in this case defined by pegs in the track every 10ft. There is no safeguard against the failure of any one motor, but the wire bracing joining the towers is strong enough to tow a tower without sustaining damage.

Each tower carries an inclinable aerial frame in the same manner as for the fixed array : the aerial proper is a dipole, and it is possible to move it within the parabola if a change of frequency is necessary. This aerial system was built by D. Mackay of Cambridge.

The long-wave aerial is larger but of much simpler construction. The reflector has only an approximate parabolic form, and the frame is built up of aluminium " Dexion " slotted angle. Each frame is attached by a single bolt to a stake in the ground : they were erected and wired with one arm horizontal, and when the first frame was pulled up to face the zenith the entire row, 3200ft long, followed in sequence. The frames each have an aperture of 40ft : the moving aerial is built up in four separate sections 10ft long, and each weighs only 1 cwt. The moving aerial can be dismantled, moved and re-erected by four people, and it is proposed to fit bicycle wheels to the light, clumsy elements, to allow two people to carry through the job.

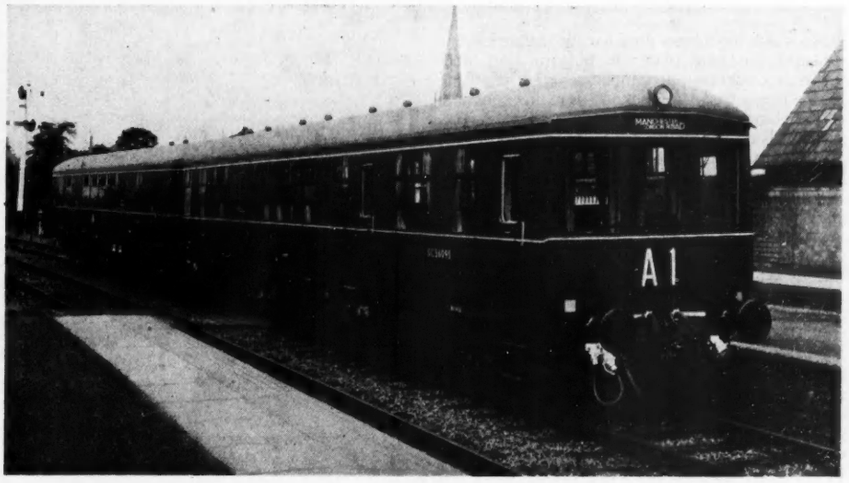


Fixed aerial of the radio-star interferometer under construction : the reflectors can be rotated through 120 deg.

Lightweight Diesel Railcars

A TUBULAR steel integral form of construction has been developed for the lightweight diesel mechanical railcars which are being built by the Gloucester Railway Carriage and Wagon Company, Ltd., for the British Transport Commission. These railcars for suburban services are intended for operation in twin sets, comprising one motor coach and one driving trailing coach, providing seating accommodation for a total of twelve first and 107 second-class passengers. Each of the cars is 57ft 6in long with bogie centres at 40ft, the driving motor coaches weighing 30 tons and the driving trailing coaches 25 tons in working order. The power equipment, following standard practice, comprises two 11·31-litre A.E.C. diesel engines rated at 150 b.h.p. at 1800 r.p.m., and coupled through four-speed epicylic gearboxes and shafts to the inner axle of each bogie of the motor coach. One of the new car sets can be seen in our illustration. Their interior finish and accommodation comply with the high standards of comfort and efficient layout which have been set for modern diesel railcars in this country. A large driver's cab at each end of the twin-car sets has its controls and instruments arranged to provide ease of driving with clear unobstructed vision.

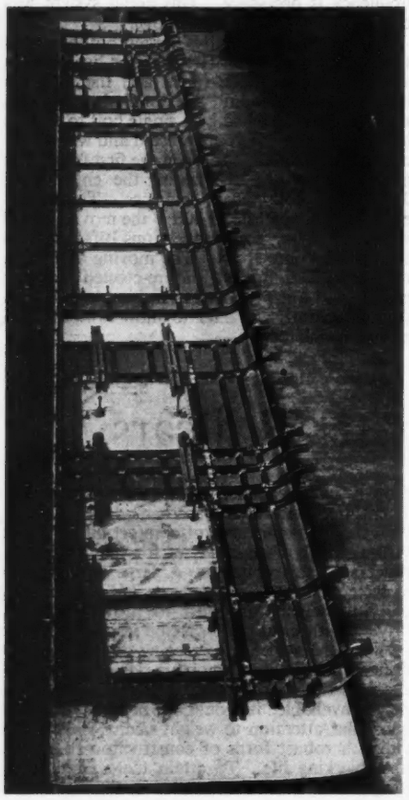
When the vehicles were being designed it was decided that, in order to obtain good acceleration characteristics for a loaded twin-car set with the power available, it would be necessary to pay particular attention to weight saving, whilst providing a robust form of construction to give a long working life. To attain these features an integral form of construction assembled from welded units was decided upon. Such a construction, however, presented a number of design problems as the coaches had to conform to the



Diesel-mechanical railcars with bodies of lightweight tubular steel integral construction

British Railways C.1. loading gauge. In this gauge a full 9ft width over the panels changes abruptly to 7ft 11in over the solebars at floor level. A form of construction to overcome these difficulties was developed in collaboration with T.I. (Group Services), Ltd. It incorporates tubular pillars which are built into the solebars and cranked at floor level to provide for the change in width. With this design the whole of the vertical loads are distributed into, and reacted by, the whole depth of the coach body side, including the solebars.

It was shown by calculation that the forces on the pillars were highest around the floor level and determined the wall thickness of the square section tubular pillars in that region. At the cantrail, however, this wall thickness was greater than that actually necessary, and it was decided to save weight by using butted drawn tubes, which could be supplied with the required variation in wall thickness whilst providing adequate strength in the different regions. The butted



Body side unit in welding fixture. The pillars of butted square section steel tubes, as can be seen, are sharply cranked at floor level to provide for the gauge requirements

tubes which have been used for the pillars have a constant thickness over the bottom 18in, and the wall thickness then tapers over a length of 12in. Thereafter, the thickness remains constant at the thinner gauge up to cantrail level. The use of this cranked butted tube for the body side pillar overcame the load gauge problem at solebar level, saved weight, and enhanced the stability and efficiency of the body side by permitting a good pillar attachment. The shape and arrangement of the tubular pillars along the body side can be seen in our second illustration, showing a body side in course of assembly on a welding fixture.

Tubes have also been used to form the bases of the fabricated solebars of the coaches, and a stiff, deep box forming each cantrail has been fabricated from cold formed sections generally of "Corten" steel. These framing members are joined by welding to form a unit with these side panels also attached by welding. As can be seen from our illustration, the resultant appearance of the body side of the coaches is quite pleasing and the design adopted has provided an integral truss.

The coach floors are built up of 57ft long, longitudinally corrugated, sections of cold rolled steel and each floor is designed to sustain both the buffing and draw loads, and supports passenger loads between crossbars. The bolster headstocks and buffing gear support structures are fabricated as unit assemblies from steel tube, sheet and plate. Diffusion of buffing and draw loads into the corrugated steel floor is achieved by incorporating tubular longitudinals immediately behind the buffing and draw gear. In order to assist the diffusion of end loads into the floor, and to save weight, these longitudinals are of butted tubes having a wall thickness which is greater at the headstocks.

The body end and roof of each coach between the cantrails follow generally standard British Railway coach practice and the cantrails serve as the main load-carrying members.

The main structural components of the vehicles are assembled by a combination of riveting and welding to facilitate repairs or, if required, replacement of certain of the major units without difficulty.

Each complete body shell weighs only just over 6 tons 7 cwt and in order to prove that the design satisfied the British Transport Commission strength requirements it was decided to test a shell, using electrical resistance strain gauges to determine stress levels at selected points. For this purpose a shell was taken out of the production line and set up in such a way as to represent the actual conditions of body support which exist in service, and a special testing rig was erected for the purpose of applying a compression load to the side buffers. On this shell the vertical load was applied by iron bars laid to represent a distributed passenger load. The end buffing load was applied by a hydraulic ram at the driving end of the coach, acting on an equalising beam which, in turn, acted on the side buffers. Another beam on rollers was held against the buffers at the non-driving end of the coach by four tie bars running the length of the coach and reacting the ram thrust of the driving end. A series of strain gauges was attached to these tie bars to measure the force exerted by the ram, which was also checked by pressure gauge.

The test programme included the following :—

(*a*) A uniformly distributed load of 17½ tons, 15 tons of which was applied and removed a minimum of five times during the course of the test programme.

(*b*) An end buffing load of 80 tons which was applied and removed a minimum of five times during the course of the tests, a uniformly distributed load of 2½ tons remaining in the coach as a settling vertical load the whole time.

(*c*) A combination of the above, i.e. a total uniformly distributed load of 17½ tons, together with an 80-ton buffing load. This combination was applied once.

A complete and detailed analysis of the results cannot be given in full here, but the makers state that the tests showed that the attention paid to the joints of pillars to solebars and cantrail, together with the use of butted tubular pillars, was justified. The vertical deflection of the coach at the solebars, midway between bogie centres, under a load of 15 tons, was only 0·13in, and the inward movement of the body sides at the waist rail of the bolster quarter, door quarter, and single pillar at the coach centre line was 0·031in, 0·055in and 0·101in respectively. These figures combine to show that the applied loads were reacted by the whole depth of the body side without distortion of the coach cross sections. Further, the stresses recorded in the pillars did not show any sudden change of stress level around the crank at the solebar.

Gauges located on the corrugated floor and the buffing gear support structure showed that the butted tubular longitudinals immediately behind the buffers diffused the end load into the whole width of the floor efficiently. The applications of the combined vertical load and 80 tons buffing load caused the coach to contract elastically 0·46in over its length, and no part of the structure suffered any permanent set.

In order to produce the eighty vehicles on order from British Railways, the company has laid down unit fabricating stations and a comprehensive group of welding fixtures to ensure the accuracy necessary for the form of construction adopted. The use of locating and holding fixtures, combined with the jigs used in producing individual component parts, facilitates and speeds manufacture to close tolerances, both in making the units and in the final main component assembly of the vehicles.

Small Craft

THE launch/tug "Efgee" has been completed recently at the yard of P. K. Harris and Sons, Ltd., Appledore, for the F.G. Towage Company, Ltd., to the designs of Burness, Corlett and Partners, Ltd. The launch, seen in our illustration, has a length between perpendiculars of 40ft 10in by a breadth moulded of 12ft 2in by a depth moulded of 5ft 5in and a loaded draught of 4ft 3in. The air draught is 4ft 6in. Four watertight bulkheads divide the hull, which is built to the designers' "Hydroconic" form of construction employing a double chine, into fore peak, crew cabins, engine-room, store space and aft peak. The power unit consists of a Foden F.D.6 six-cylinder, two-stroke diesel engine, of 85mm bore and 120mm stroke, coupled to a Thornycroft hydraulically operated, reverse/reduction gearbox of 2·85 to 1 ratio.

Launch/tug "Efgee" running free

At 1800 r.p.m. the engine has a continuous output of 100 s.h.p., and it is expected that the time between major overhauls will be not less than 5000 hours. The overhaul arrangements are based on the replacement of the complete unit, which can be carried out within twenty-four hours. On trial the tug attained an average mean speed of

Sudan Government's tug " El Tigeel " on trial

8·7 knots with the engine running at 1800 r.p.m. and the static bollard pull achieved was 1·35 tons. The time taken to stop the tug from full-speed running free was found to be fifteen seconds, and steering trials showed that the diameter of the turning circle was about two boat lengths.

Also constructed on the " Hydroconic " system are the two tugs " Arthur " and " Varco," which were built by T. Mitchison, Ltd., at Gateshead, for Samuel Williams and Sons, Dagenham. The " Arthur " has a length overall of 72ft 3in and a length between perpendiculars of 66ft by a breadth moulded of 18ft 3in and a depth moulded of 9ft 6in, the draught aft being

Light alloy launch for the Niger delta

8ft 6in. In this craft the deck arrangement has been designed to give maximum all-round visibility, and to assist in this the orthodox funnel has been omitted and the main engine exhausts led up small trunks built into the aft corner of the wheel house structure. For propulsion there are installed two National Mark R4A.M.6, four-stroke, diesel engines having six cylinders of 9in bore by 12in stroke. These engines develop a total of 500 s.h.p. at 600 r.p.m. and drive a single propeller shaft through a twin input, single output Hindmarch/M.W.D. reverse reduction gearbox to which they are connected by a traction pattern hydraulic coupling. On trial a running free speed of 9·47 knots was recorded and a static bollard pull of 7·25 tons measured by dynamometer.

Another tug recently completed is the " El Tigeel," which has been built at the Berwick shipyard of the Fairmile Construction Company, Ltd., for the Sudan Government and for duties at Port Sudan. Built of steel, the tug, which can be seen in our illustration, has the following dimensions :—length overall, 74ft 10in ; length between perpendiculars, 69ft ; breadth moulded, 18ft 6in ; depth moulded, 9ft 3in ; maximum draught, 8ft.

Subdivision of the hull provides for forward and aft ballast tanks, a crew space forward, an engine-room having a transverse cross bunker of 10 tons capacity at the fore end, and a hold immediately aft. Hydraulic deck gear is fitted and two 5-ton spring towhooks, one fitted aft of the funnel and the other fitted at the aft end of the casing. Goodyear rubber fenders having an outside diameter of 15in and an inside diameter of 7½in are placed forward around the stem, which has been strengthened for bow pushing, and supported by a strong steel cradle attached to the shell.

The propelling machinery consists of a Ruston and Hornsby Mark 6VEBM four-stroke diesel engine, having six cylinders of 10·25in bore by 14·5in stroke, driving a cast iron, four-bladed propeller through an oil-operated reverse-reduction gearbox having a reduction ratio of 2 to 1. Salt water cooling is employed and the engine develops 313 s.h.p. at 500 r.p.m. Bloctube controls are fitted and the hydraulic power for the deck auxiliaries is provided by two pumps, belt driven from the forward end of the engine, while electrical requirements are met by a 1½kW diesel-driven generator. The tug, having a trial displacement of 94·6 tons, attained a running free speed of 9·70 knots, and the time taken to bring the ship to a stop from full speed ahead was thirty seconds, while the turning circle had a diameter of two and a half lengths. With the engine running at 450 r.p.m. a static bollard pull of 4 tons was recorded.

Another illustration shows one of two launches, recently delivered to Shell Tankers, Ltd., which are the first of six similar craft at present under construction for service in the Niger delta, where the Shell-B.P. Petroleum Development Company of Nigeria, Ltd., is engaged in exploring and developing oil resources. The general-purpose launches, which have been built by Universal Shipyards (Solent), Ltd., are named " Afara " and " Ntala," have a length of 32ft and are constructed on the " two-way tension " system using 12 s.w.g. light alloy to specification N.S.5 supplied by the British Aluminium Company, Ltd. The forward part of the accommodation is enclosed, while a canvas awning is provided to cover the cockpit, and there is seating for a total of thirty-five passengers. Each launch is powered by a Perkins S6 diesel engine, having six cylinders of 111mm bore by 127mm stroke, and derated to develop 91 b.h.p. at 1900 r.p.m. On acceptance trials both launches attained a mean speed of over 17 knots.

Surface Finish Microscope

An instrument which has been introduced by C. Baker of Holborn, Ltd., 244, High Holborn, London, W.C.1, for surface finish measurement, is stated to use interference microscopy with a system based upon a modification of that devised by Mirau. According to particulars received from the makers, the equipment provides a means of visual assessment of an area of a specimen rather than being limited to a point, and it is possible to assess a surface to about 1 micro-inch.

In this instrument the optical system uses only one objective, and in it the division and recomposition of the light beam is confined to the small space between the objective and the specimen. The unit of measurement used is the wavelength of the green band of the spectrum and the light is derived from a special mercury lamp. Since the light used is the source of the unit of measurement, the instrument requires no external calibration and is unvarying in its accuracy. To change from visual inspection to camera setting, a knurled disc is used to turn a prism in the system. The camera lens is fixed in the microscope and normally covered.

The microscope is a self-contained unit which can be traversed vertically, over a sufficient distance for focusing, on steel balls running in

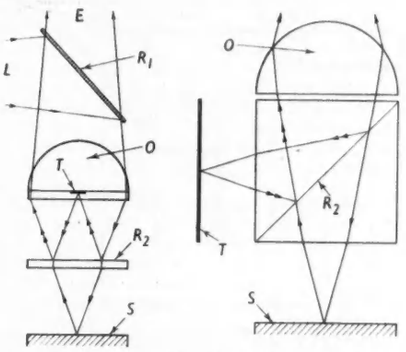


Fig. 1—Diagram of the high (×40) and the low (×10) power objective systems of surface finish microscope

long vee-ways. A counterpoise weight controls the motion of the object table and in effect the microscope is in balanced suspension, a system which has been found to provide the necessary stability for operation.

It is necessary to provide a slight tilt for the optical system to generate the interference fringes, and for this purpose the table is carried on a ball support. The main table carrier is in the form of a yoke running vertically in long guideways in the housing ; this yoke has a bowl-form coaxial with the microscope. The form carries a hemispherical insert which may be universally tilted, and has a top plate of hardened steel which supports the specimen table. To obtain the required movement a special silicone grease is applied between the optically lapped and polished mating faces of the instrument. Adjustment of the specimen is made by sliding the table on the carrier. The tilting action, which may be clamped when set, allows adjustment of the fringe spacing as seen through the eyepiece.

The fringe pattern is analogous to the well-known Newton's fringes, and the microscope system produces similar conditions to those that obtain when a test glass is placed in contact with a flat specimen that reflects light. There is no contact between the optical unit and the specimen.

The low and high power objective systems, shown diagrammatically in Fig. 1, are similar in function. Light from the lamp L is reflected by a semi-reflecting surface R_1 to the back of the objective lens O. The objective lens focuses the light upon the specimen surface S. In passing from the objective to the specimen surface the light encounters a second semi-reflecting surface R_2 which reflects some of the light back to illuminate an optically-worked metal-coated reference surface T. Further reflection from this surface results in its image coinciding with the

image of the specimen S seen in the eyepiece. The spot T and the specimen S are optically equidistant from R_2. Therefore, the effect obtained is the optical equivalent of the reference plane T being placed in contact with the specimen surface S. An interferometric comparison occurs and the recombination of light from S and T produces the fringe pattern.

It is necessary for the reflectivity of the reference T to suit the specimen. Two objectives are accordingly made available; one suits metallic surfaces and the other is suited to paints, and ceramics. A total of four objectives will thus provide magnifications of $\times 400$ and $\times 100$ for metallic and non-metallic surfaces.

The measuring principle depends upon two well-established facts. First, all points along the surface intersected by one fringe are equidistant from the reference surface. Thus, the fringe follows a path that provides a contour map of the specimen surface as indicated by LMN in Fig. 2. Secondly, the difference in level of the specimen between any two fringes is invariably one-half of the wavelength of light chosen for

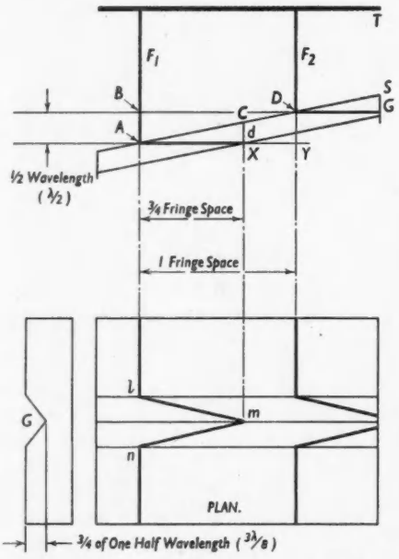


Fig. 2—Measuring principle of surface finish microscope

illumination. In this case the wavelength of green light (λ) is 0·546 micron or 21·6 micro-inches. Referring to the Fig. 2, to find the depth of the groove it is only necessary to compare the distance AX with the fringe spacing AY; this ratio equals the ratio of the depth at X to half the wavelength of light used. This may be written :

$$\frac{AX}{AY}=\frac{d}{\frac{1}{2}\lambda} \text{ or } d=\frac{\frac{1}{2}\lambda \,.\, AX}{AY}$$

where d is required depth and $\frac{1}{2}\lambda$ is 0·273 micron or 10·8 micro-inches. It will be seen that, by visual inspection, it is possible to estimate surface irregularities to 0·1 of a fringe interval or about 1 micro-inch.

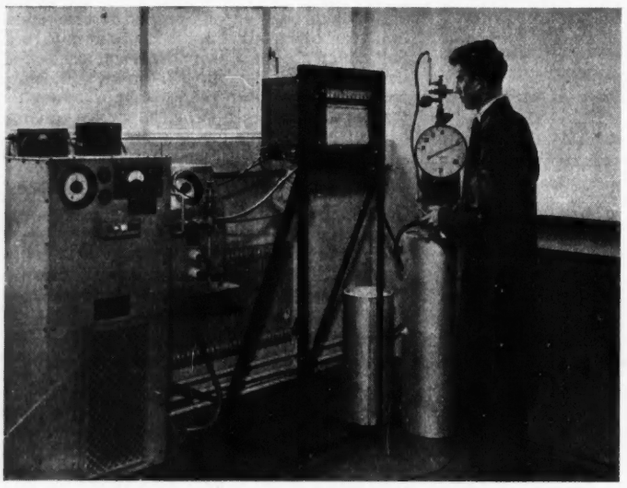
From photomicrographs it is only necessary to establish the ratio AX/AY and multiply by the half wavelength to have a precise measurement of the depth or height of any irregularity. The operation is aided by adjusting the tilt of the table, which varies the spacing of the fringes. The actual dimension is in no way changed by tilting and the accuracy of the system remains constant, but it is sometimes easier, when the surface is poor, to identify one fringe.

Differentiation between grooves and ridges in the specimen is simple. The fringes run against the tilt of the table when following a groove and, conversely, they run with the tilt of the table when meeting a ridge. To ensure proper interpretation of photographs, a mark in the camera system is transferred to the negative to provide orientation. It is then only necessary to make a note of the direction of tilt, forward or backward, when taking the picture to be certain of the results. The instrument, it is stated, can be applied to plane, spherical or cylindrical surfaces with equal facility. Spherical surfaces show ring fringe patterns, and cylinders show parallel or elliptical patterns according to the orientation of the work. Inspection of internal surfaces is carried out by the established practice of taking plastic-film replicas.

The instrument has a 7in diameter table which, when fully lowered, gives a 5in clearance between table top and objectives.

British Welding Research Association's New Laboratory

A NEW metallurgical laboratory at Abington, near Cambridge, was officially opened for the British Welding Research Association by Marshal of the Royal Air Force the Right Hon. the Lord Tedder on July 23. The building itself has a welded portal structure designed according to criteria based on the plastic-hinge theory of collapse—this theory having been developed by Professor Baker at Cambridge University with financial aid from the B.W.R.A. The laboratory is



Rapid-action dilatometer for determining transformation temperatures, shown at the recent B.W.R.A. open day. The transformation temperature is an index of weldability

equipped for metal-arc and gas-shielded welding, much use being made of automatic traversing.

Work on arc characteristics is being done in collaboration with the Electrical Research Association. The influence of electrical parameters on metallurgical properties is thought to be of particular importance in gas-shielded welding.

A special nozzle has been devised to increase shielding in aluminium welding, and it is reported that well-shaped and sound deposits have been made with this kind of nozzle at currents up to 600A. Existing nozzles are limited to 350A because defective ("puckered") welds result at higher currents. Guests saw the device working at 500A and producing an apparently excellent weld between plates 1in thick. A more advanced design of nozzle is at present under development.

Recent work in the laboratory has shown that Mn/S ratios of about 25 : 1 suffice to prevent cracking in weld metal containing less than 0·15 per cent carbon. A high Mn/S ratio is still beneficial for carbon contents exceeding 0·15 per cent, but prevention is not complete.

Investigation of process variables in welding with a carbon dioxide shield has suggested, unexpectedly, that there is a threshold current of 400A. Confirmation is being sought, since this conflicts with current belief.

Specimens brazed in hydrogen, using high-frequency induction heating, are tested at 650 deg. Cent. in ¾-ton creep-testing machines. Discs spaced two, five, or ten thousandths of an inch apart are brazed, and then one disc is machined away to show what filling has been achieved with the particular alloy used.

Welding characteristics and properties of titanium and zirconium alloys are being examined, and the technique of "open-air" welding of reactive metals generally is being investigated. Test welds are made in a chamber which can be evacuated to 10^{-5}mm Hg before filling with very pure argon. The effects of argon velocity, nozzle diameter and nozzle-work separation on the shielding area has been investigated (for round nozzles) on "open-air" equipment comprising a traversing table, perforated backing bars, torch and a mechanised wire-feeding arrangement.

Previous work by the Association showed that the transformation temperature of a steel indicates its weldability. The method developed to exploit this fact is to place a small sample of the steel in a dilatometer (see illustration), heat in a high-frequency induction coil, quench in an argon stream, record dilatation and time against temperature, and then estimate the transformation temperature from the curves obtained.

A method is being developed for the identification of gases in the spaces occurring in weld metal. The specimen is stretched to fracture in a vacuum chamber, and the released gases are then analysed qualitatively.

Stress distributions have been measured under five loading patterns on various welded branch pipe connections. The conventional collar reinforcement has been shown to be reasonably effective. Tests on a large plate containing a 24in manhole with standard reinforcement indicated a stress concentration factor of 2. It has been found possible to redesign the manhole neck so that the reinforcing plate can be discarded without increasing the concentration factor. A method of design has been developed accordingly.

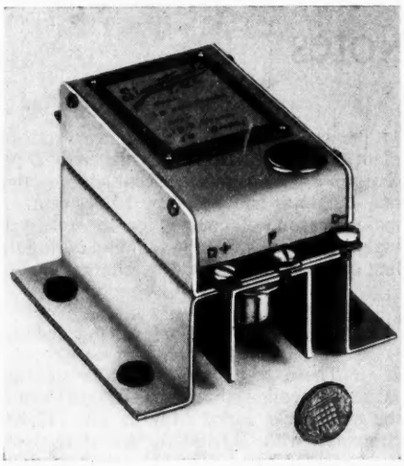
A 700-ton test rig is in use in the brittle fracture laboratory. This was designed to break steel specimens 48in by 36in by 1in. Four oil-hydraulic capsules working up to 5000 lb per square inch exert load with a stroke of up to 0·4in. Pulsating loads can be applied. For static tests, cooling is by solid carbon dioxide in boxes; a brine spray is used for repeated loading tests. A 2000-ton rig is under construction.

Fatigue in welded joints is being extensively investigated in a laboratory devoted to the subject.

The twelfth annual report of the Association, covering activities in 1956–57, has now been issued. It shows an income of £157,444 and an expenditure of £135,911. The portion of the latter actually devoted to research was £108,020, while £15,216 went on administration, removal, &c.; the remainder was spent on publications, library, advisory service, and so on.

Electrical Control Devices

WE have received advices of two advances in electrical control technology. Simms Motor Units, Ltd., have built and applied experimentally transistor regulators for automobile low-voltage generators. In addition to the expected reliability and immunity to environment, the electronic regulator has the additional advantage over vibrating contact designs that it does not propagate radio or television interference. The units built up to the present have incorporated current and voltage control, using a grounded emitter circuit with silicon and



Regulator giving current and voltage control of an automobile generator, using silicon and germanium transistors

germanium diodes for voltage and current references respectively. The cut-out function is performed by a germanium diode : in place of the usual discharge warning light, a charge assurance light is used, since this provides a desired non-linear resistance. Our illustration shows a "Simmtronic" set to handle 10A at 13·8V. Models for 24V operation are now being built for trial purposes.

For control applications needing potentiometers of high consistency with linear, logarithmic, or other characteristics, the Swindon Components Division of the Plessey Company, Ltd., are now able to produce moulded carbon resistors. Typical end-to-end resistances are held within ±5 per cent, while linearity is within ±2 per cent. It is claimed that temperatures between −40 deg. and 100 deg. Cent. and even the presence of oil do not degrade the performance prohibitively. Trial potentiometers have, we are informed, successfully survived 10^7 operations. The form of the element can be adapted to the application, but existing examples include straight tracks for machine tool control, which can be assembled into total lengths of several feet, and a potentiometer generating a sine wave as a brush is rotated on the track.

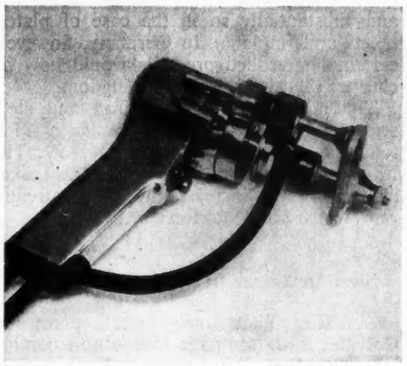
Lightweight Stud Welding Equipment

ABOUT eighteen months ago a specification was drawn up by Crompton Parkinson, Ltd., Crompton House, Aldwych, London, W.C.2, to meet a demand for a lighter and more portable stud welding equipment than was then commercially available. The specification visualised a portable hand tool capable of welding attachments up to ⅜in diameter in ferrous and non-ferrous metals, and having an overall length such that with a 1in long attachment the maximum headroom required would be 9in. The controller should be light and readily portable, and should require no power for control purposes other than that obtainable from a standard welding current source. The hand tool should incorporate a means of self-adjustment to cater for small variations in stud or attachment length, and design of the controller was to embody the established pilot-arc principle.

To meet this specification the company has developed the "Cromp-Arc" J/K equipment, which consists of a hand tool weighing just over 5½ lb (including the weight of the associated 15ft of welding and control cable) and a controller weighing only 26 lb. The hand tool (illustrated here) measures 7½in overall when loaded with a 1in long stud ready for welding. The self-adjustment requirement has been met so that consistent stud lift or arc length can be maintained despite variations in stud or attachment length by ±¼in, nd the tool can be used for studs from ⅛in to ⅜in diameter. To cater for the different studs which can be used, a range of suitable taper shank chucks and ferrule grips are provided, together with tools for adjustment.

The tool body is built up from two light alloy shell castings with an integral pistol handle containing the operating spring-loaded push button and enclosing the operating coils and adjustable lifting device ; weld and control cables enter at the heel of the handle, providing good balance for the tool's use. A rotatable clamp ring is provided on the nose of the tool to provide a simple means of gripping an adjustable leg, the length of which may be quickly varied to accommodate different lengths of attachment up to 3½in long. A single-point foot at the bottom of the adjustable leg is interchangeable with the standard feet of the established "Nelson" stud welding tools and it can therefore take the complete range of "Nelson" standard ferrule grips which are provided.

The controller measures only 7½in wide by 11½in deep and 11½in high in a drip-proof, sheet steel, vented case finished in durable silver-grey hammer stove enamel, and fitted with a carrying handle and rubber feet. The front panel is recessed to provide protection for the timer control, plugs and sockets, and pilot lamp



The stud welding gun shown here weighs a little over 5½ lb and can weld studs from ⅛in to ⅜in diameter. The controller (not shown) measures 7½in by 11½in by 11½in and weighs 26 lb

mounted on it (the lamp gives visual indication that the unit is energised). The equipment consists, essentially, of two electromagnetic relays, a timer and a contactor. Timing of the welding current is by means of an established pneumatic device having a good degree of repetitive accuracy and reliability, and indication of the selected time setting is by a dial which is visible through an aperture in the front panel. Welding plugs are mounted behind, and shielded by, the front panel on which a watertight, four-pin socket is provided for hand tool control circuits.

For connections between the controller and source of welding current, the controller and hand tool, and the source of welding current and work, a set of cables 15ft in length is provided as standard.

Hydraulic Turntable Fire Escape

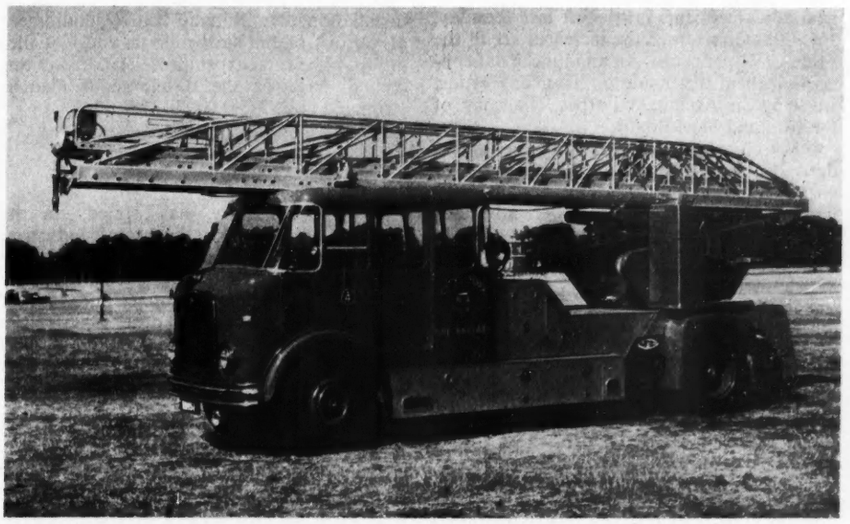
MERRYWEATHER AND SONS, Ltd., Greenwich High Road, London, S.E.10, has introduced a 100ft turntable-ladder fire escape in which all the motions are hydraulic. The improvement over past hydraulic escapes stems largely from developments in the aircraft industry.

There is a minimum of controls on the new appliance—one lever for each of the three main motions (rotation, elevation, extension), and one "loading" pedal ; "plumbing" (to prevent overturning on sloping ground) is automatic. The operator sits on a platform rotating with the ladder, and he has all the controls and instruments on a panel before him.

The adoption of hydraulic power transmission based on standard components is claimed to have reduced from months to weeks the time required for maintenance, and the cost of the latter is said to have been divided by eight. It is stated that certain of the combinations of hydraulic control equipment are new, and few details of the circuit are being released for publication. A Mirrlees engine-driven triple-screw pump supplies continuously filtered oil to the Keelavite gear motors. Engine speed is governed automatically according to the demand from the hydraulic services. Twin cylinders (with an integral control valve) elevate the ladder, a reversible hydraulic motor drives a worm reduction gear to rotate the assembly, and another hydraulic motor drives the mechanism to extend the ladder. The speed of each of the three motions is determined uniquely by the position of the relevant control lever, and is infinitely variable between zero and maximum. The "loading" pedal on the operator's panel sets the whole mechanism in readiness, and individual controls have no effect until this pedal is pressed down.

The maker claims to have paid particular attention to safety. Top and bottom stops limit both elevation and extension; impact stops are provided on the three main motions so that obstacles such as window sills cause little trouble. The speed of depression as the ladder approaches the headrest is automatically restricted, and neither extension nor rotation is possible when the ladder is on the headrest. At angles of elevation less than 30 deg. the ladder is guided back to centre before lowering on to the headrest. Of particular interest are the self-actuating mechanical locks on the elevating cylinders, designed to sustain the load if hydraulic pressure fails: the details of operation are at present being withheld by the manufacturer. All electrical supplies are drawn from the main vehicle battery. Indicating devices only, not controls, are electrically operated.

The appliance is mounted on a Merryweather-A.E.C. chassis powered by an A.E.C. diesel engine of 120 b.h.p. The gross weight of the vehicle is about 9¼ tons.



The 100ft turntable-ladder fire escape shown is hydraulically operated throughout, electrical methods having been ruled out (except for instrumentation) because of the conditions under which such machines must operate

Industrial and Labour Notes

Productivity, Prices and Incomes

On Thursday of last week, during a debate in the House of Commons on the economic situation, the Chancellor of the Exchequer, Mr. Peter Thorneycroft, announced the Government's intention to establish an independent and impartial council on prices, productivity and incomes. That council, he said, would have terms of reference as follows : " having regard to the desirability of full employment and increasing standards of life based on expanding production and reasonable stability of prices, to keep under review changes in prices, productivity and the level of incomes (including wages, salaries and profits) and to report thereon from time to time."

The council, he explained, was not there to arbitrate, it was not a wage court, and it was not concerned with specific wage claims or disputes as was a wage-fixing body. Its purpose was to survey past experience and to deduce from it some guidance for the future. Clearly, he added, it could not concern itself with every aspect of economic policy. The council would be free, however, to comment on general problems inside the scope of the terms of reference, such as the effect of increased costs and prices on the competitiveness of United Kingdom exports, on the ability of the United Kingdom to pay its way abroad, and on the relationship between incomes, profits, investment and productivity.

On the day before the Chancellor's announcement, the general council of the Trades Union Congress made a statement about consultations with the Government concerning the proposal to set up this independent body. The statement said that the general council had noted the Government's proposal. It had further noted the assurances of Ministers that this body would not interfere with the present system of collective bargaining or intervene in any negotiations or disputes in an industry. The statement ended with the comment that the general council " reserved its position on this proposal of the Government."

Iron and Steel Prices

Increases in the maximum prices of iron and steel came into effect last Monday, July 29. On average the increases are of the order of 7½ per cent. An announcement concerning them was made on Thursday of last week by Sir Archibald Forbes, chairman of the Iron and Steel Board.

Sir Archibald said that the increased prices derived mainly from the successive increased costs with which the iron and steel industry had been faced. When prices were advanced last December it was stated that certain increases in costs which had arisen during the autumn of 1956, or were likely to arise, had not been taken into account, as their extent and duration could not at that time be forecast. Those costs had now been carried by the industry for about nine months and it was possible to assess the probable permanent burden which they represented. In addition, Sir Archibald continued, there would be a substantial increase in cost as a result of higher charges announced for coal, coke, scrap and inland transport, and other consequential price changes. There had also been further increases in the cost of certain imported materials. Sir Archibald said the Iron and Steel Board took the view that it would not be possible for the industry to carry the heavy burden represented by these increased costs and at the same time support its major investment programme for modernisation and expansion. Moreover, the Board had thought it necessary to increase the allowance for depreciation and obsolescence of fixed assets in the light of technical changes which had occurred or were in prospect. Sir Archibald added that, with the increases, prices in the United Kingdom for products of open-hearth quality would in general still be below those for products of similar quality in the other main steel producing countries, and substantially so in the case of plates, sheets and tinplate. In Germany, however, certain light rolled products would now be cheaper than in the United Kingdom.

The maximum prices of iron and steel scrap were increased by an average of £1 a ton, or by about 10 per cent, on July 29. The Ministry of Power says that this takes account of the increases in railway freight rates which came into force on August 1.

Steel Development in Scotland

The Ravenscraig steel plant of Colvilles, Ltd. (see page 159) is now coming into operation. It represents the first stage of the company's development plan. The second stage of the plan has been announced ; it will include a second blast-furnace at Ravenscraig and a duplicate set of coke ovens. Alongside the melting shop at Ravenscraig, a new slabbing mill is to be erected, which will replace the out-of-date mill at the Dalzell works. This old mill is to be scrapped and cleared away and the space thus becoming available will be used for improvements at the Dalzell plate mill to enable the output to be increased to 6000 tons of plates a week. The plate mill at Clydebridge is to be replaced by a modern four-high mill designed for an output of 7000 tons a week. At the company's Hallside works, an alloy billet producing plant is being built which, it is hoped, will be finished towards the end of next year. Other developments include extended capacity for the production of light steel castings at the works of the Clyde Alloy Steel Company, and the installation of automatic control equipment at various of the steel mills in the Colvilles group. The total expenditure involved in this second stage of the development plan is estimated at £32,000,000.

Industrial Production

The Treasury has stated, in its *Bulletin for Industry*, that total industrial production in this country rose in May and was almost back to the peak reached at the end of 1955. Between January and May of this year the rise was of the order of 2 to 3 per cent for all industries considered together. At the end of May the index (1948 = 100) stood at 139–140, compared with 136 at the end of last year.

The *Bulletin* says that gross fixed investment, in both the public and private sectors, continued to increase in the first quarter of this year, though the rate of increase stayed well below the first half of last year. In the first three months of this year the volume of spending on vehicles, ships and aircraft was 11 per cent lower than a year earlier ; on plant and machinery it was higher by 2 per cent, on dwellings by 5 per cent and on other new buildings and works by 10 per cent. A major reason, of course, for the relatively high rate of investment in building during the first quarter was the good weather.

Employment in the Coal Mining Industry

The average weekly number of wage earners on colliery books in Great Britain in the four weeks ended May 25 was 712,400, compared with 711,100 for the four weeks ended April 27, and 705,600 for the four weeks ended May 26, 1956. The total number effectively employed in May this year, however, was 648,300, compared with 635,900 in the corresponding period of 1956 ; these figures exclude wage earners who were absent for any reason (including holidays) for the whole of any week.

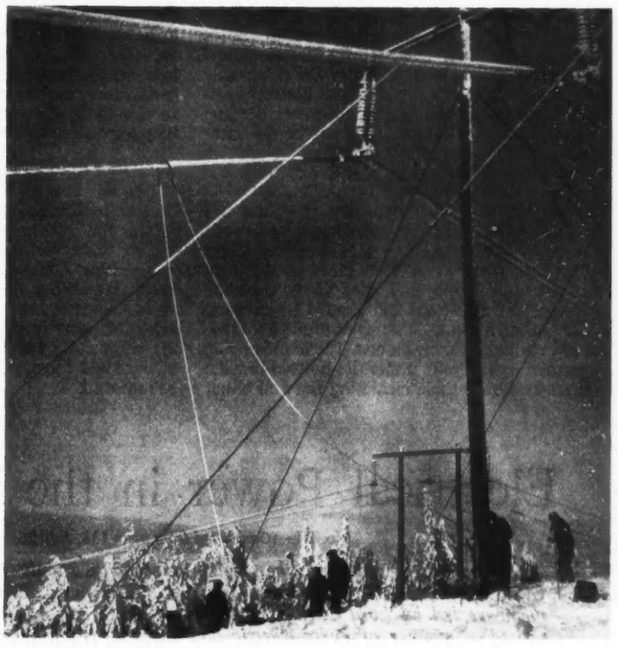
It has been estimated provisionally that, during the four weeks of May, about 6430 people were recruited to the coal mining industry, and that the total number leaving the industry during that period was 5630 ; there was thus a net increase of 800 in mining manpower. In the four weeks of April the net gain was 360. The average number of shifts worked per week by face workers who were effectively employed in May was 4·86, compared with 4·55 a year earlier, the corresponding figures for all workers effectively employed being 5·37 and 5·05. For face workers, the output per man-shift worked was 3·42 tons in May, compared with 3·32 tons in the corresponding month of last year.

Mission to Canadian Oilfields

On Thursday of last week a conference was held under the chairmanship of the Minister of State, Board of Trade, Mr. D. Walker-Smith, to discuss the report of Mr. J. M. Storey, the leader of the Economic, Technical and Goodwill Mission to Canada, which was sponsored by the Council of British Manufacturers of Petroleum Equipment.

Mr. Storey, in his report, stated that the crude capacity of Canadian refineries had increased from 300,000 barrels to 700,000 barrels per day, although production was restricted to about 500,000 barrels per day at present. Current expenditure was said to be £275 million per annum, of which exploration, drilling and concession costs accounted for £114 million, pipelines and pumping stations £101 million, refinery construction £41 million, and distribution £19 million. Of the total, the United Kingdom's share was given as about 5 per cent, so that there was ample opportunity for expansion. The mission established that British equipment was acceptable, both as regards price and quality, but that some 90 per cent of material supplies came from American sources. Canadians buy on a basis of price, delivery time, and after sales service, and Mr. Storey said that where the labour content in the price was high then the sales position was favourable. However, it was necessary to maintain stocks and spares in the country, to maintain constant contact through visits of technically qualified representatives, supplemented by technical literature containing full information.

"Hot Line" Maintenance in Sweden



"Hot line" maintenance, i.e. the prevention and repair of breakdowns on live transmission lines, is now widely practised in Sweden. The method ensures fewer interruptions of the power supply and is preferred by the men because repairs can be carried out during normal working hours. For all "hot" work, equipment and training must be to a high standard. The article describes some of the aspects involved.

PREVENTIVE maintenance and repairs to transmission lines are important and difficult problems in Sweden, in view of the extent of the country and the extreme climatic conditions which may be encountered. Methods developed in recent years allow much of the work to be carried out while the lines remain under tension. These "hot" methods have the advantage that the supply need not be interrupted, and also that work can be done during normal hours and in optimum conditions, instead of having to be confined to such times when breaks in the service have least effect.

In a recent report* the Swedish State Power Board describes the way the new techniques are being applied. Great care in the design and maintenance of the tools and in the training of the personnel are, of course, essential.

The Board maintains central training institutions and testing grounds, and also runs courses in conjunction with work actually in progress. All equipment is tested at regular intervals for its mechanical and electrical condition.

Insulator Testing

Aerial and ground surveys of power lines are supplemented by regular inspections of the insulators, the intervals depending on past experience. In the case of the 400kV lines, for instance, a twelve-year interval is adopted in most cases at present.

* O. D. Zetterholm and L. G. Bergman, "Hot Line Maintenance Work." Stockholm: Swedish State Power Board, Blue-White Series No. 17.

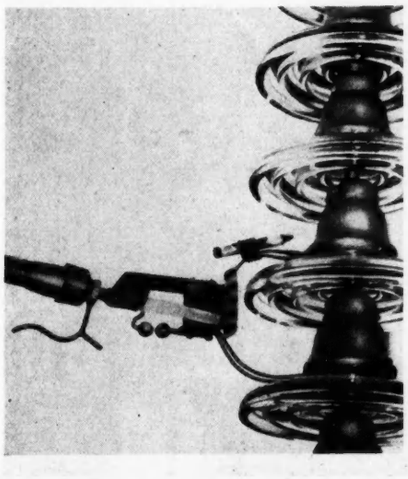


Fig. 1—Insulator test gear. The scale and pointer show the width of the spark gap. Note the chalk for marking defective insulators

Insulators are tested under power by being short-circuited individually by test gear, such as the one shown in Fig. 1. Those that fail the test are chalk-marked and later removed. The test gear is mounted at the ends of bamboo rods extended with fibre glass plastic tubes. In the case of voltages of 200kV and over fibre glass plastic alone is used.

De-Icing

Severe ice conditions on power lines put a great strain on the wires, and may even destroy towers by causing flashovers. The State Power Board therefore maintains an emergency service,

Fig. 2—Vibration damper (right) and damper tool for hoisting the damper into position

which receives warnings from the State Meteorological Institution. Should a danger of ice formation occur patrols are sent out, in particular along the main lines. If ice is encountered, a thin nylon cord is shot over the line by means of a bow and arrow or in some other way. With the help of this cord a thicker polyethylene cord with a short wear-resistant part in the centre is pulled over the conductor. The ice can now be shaken or scraped off.

Vibration Dampers

Another field where "hot line" maintenance has been applied is the installation of vibration dampers. A change in conditions, such as a new cutting in the forest, may necessitate the placing of new dampers or the altering of existing ones.

The principal tool for this work is shown in Fig. 2. The other tools are a tool stick, a polyethylene cord, and a pulley block with adjustable fastening. The pulley is hooked on to the cross arm of the mast, allowing the damper tool and damper to be raised into position, the stick serving to place it accurately on the conductor wire. After this the clamping nut of the damper is tightened by means of a universally-jointed socket wrench at the end of an insulating rod; the damper tool and pulley block can then be removed. It is stated that dampers can be installed by two men on live 70kV to 400kV lines in as little as eight minutes.

Changing of Insulators

Methods for the changing of insulators on lines of 70kV, 130kV and 200kV have already been applied with a good deal of success. Similar methods are ready for use on 400kV lines, but up to the present no actual case has arisen.

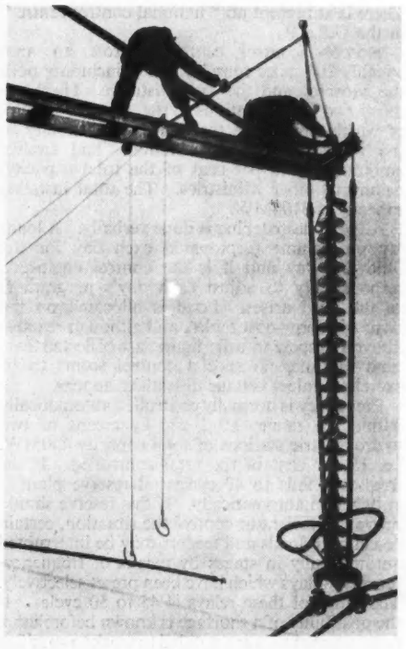


Fig. 3—Setting up of temporary shear legs prior to lowering 400kV insulator. The weight of the line is taken up by the two adjustable insulating rods. At the bottom, tool rod steadied by suspended hook

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For shorter insulator strings (up to 200kV) the method consists in mounting a special pulley block on the cross beam above the insulator. Nylon ropes passing over pulley on either side then hook the line and, after the bottom insulator clamp has been unscrewed, lower the line through a short distance. The top of the insulator is then unbolted, after which it can be lowered to the ground. For reassembly the same process is carried out in reverse.

In the case of 400kV insulators things are made more difficult by the longer tool rods required as well as by the greater weight of the insulators. The fibre glass plastic tool bars are 4·5m long and have to be steadied by being rested in hooks suspended from nylon cords. Fig. 3 shows the second stage of the removal of a 400kV insulator. The load is being supported by the yoke under the bottom bracket and the two adjustable insulating rods on either side. A shearlegs is being erected on the cross arm. A nylon rope will then be passed over the shearleg pulley by which the insulator will be lowered to the ground. In order to clear the conductors, the shearlegs can be tilted forward. In this class of work much use is made of telescopic spectacles and mirrors.

Erection and Changing of Poles

The erection of additional new poles may become necessary, e.g. in cases where experience shows that there is danger from heavy ice loads. Such work has been carried out successfully on live 40kV and even 130kV lines. Similarly, damaged poles have been replaced. In all such cases the new pole complete with insulators is erected beside the existing line and the conductors transferred to it with the help of insulated tools. The damaged pole can then be removed.

Electrical Power in the U.S.S.R.

No. III—(*Concluded from page* 138, *July* 26)

A delegation representing the British electricity supply industry visited the U.S.S.R. from April 16 *to May* 14, 1956. *The party, consisting of nineteen members led by Lord Citrine, chairman of the Central Electricity Authority, visited a number of hydro-electric and thermal stations, including the experimental atomic power station,* 80 *miles from Moscow, controlled by the U.S.S.R. Academy of Sciences. The tour also included Noginsk substation, an experimental d.c. installation, a load-dispatching centre, cable-making and generating plant factories, and research institutes. Some impressions of electrical power transmission practice in Russia are given in the following résumé of part of a recently published report on the visit.*

System Operation

THE electricity supply system in Western Russia is really a number of localised supply systems based on such centres as Moscow, Leningrad and Sverdlovsk, each dependent on generating plant within its own group, to which fuel may be transported over distances of the order of 600 miles and each having its own central control room. The installation of the new Kuybyshev-Moscow 400kV line marks the beginning of a new stage in which not only will energy be transmitted electrically from points well outside the group, but gradually there will be established an interconnecting grid which will pool the plant in much the same way that the 275kV grid pools the plant in Britain. There is at present no " national control centre " in the U.S.S.R.

Moscow control centre controls an area roughly 200 miles round the city, including both the Moscow and the Tula districts. There are thirty-two power stations in the Moscow system, of which twenty are the direct responsibility of the Ministry of Power Stations, and twelve, amounting to 6 per cent of the total capacity, belong to other Ministries. The total installed capacity is 3100MW.

All load despatching is done verbally. A loading programme is prepared each day for the following day and it is the control engineer's responsibility to adjust each day's programme as the need arises. Load is allocated on the basis of energy-cost tables, and although reactive kilovolt-ampere transfer figures are collected from time to time, no special control seems to be exercised unless voltage difficulties appear.

Frequency is normally controlled automatically within the range ±0·2 c/s, by means of two hydro-electric stations of total capacity 440MW, i.e. 15 per cent of the total controlled. If the frequency falls to 49 cycles all reserve plant is switched in automatically. If this reserve should prove insufficient to control the situation, certain consumers' loads and feeders may be interrupted automatically in stages by means of frequency-sensitive relays which have been preset selectively. The range of these relays is 45 to 50 cycles. If the possibility of a shortage is known beforehand, certain consumers are notified to work to specified limits, and, if the request is not complied with, the consuming undertaking may be fined, and the responsible engineer at the consuming undertaking and even the load despatcher may, in addition, be fined, the fines being payable direct to the State.

Cloudy conditions at midday in Moscow can cause a load increase of 100MW, but a drop in temperature of 2 deg. Fah. causes a load increase of only 6MW.

The Urals Electrical System controls 4000MW of generating plant, including 100MW of hydro-electric and 600MW of factory plant, from the control centre at Sverdlovsk. The area is 700 miles long from north to south, and rather more than half of this in width. There are 11,000 miles of line in the area, operating at 220kV, 110kV and 35kV. The present five-year plan includes proposals for two 400kV lines from the west. At this control centre the same normal limits of frequency apply as in Moscow, but load-shedding begins at 49·5 cycles.

High-Voltage D.C. Transmission

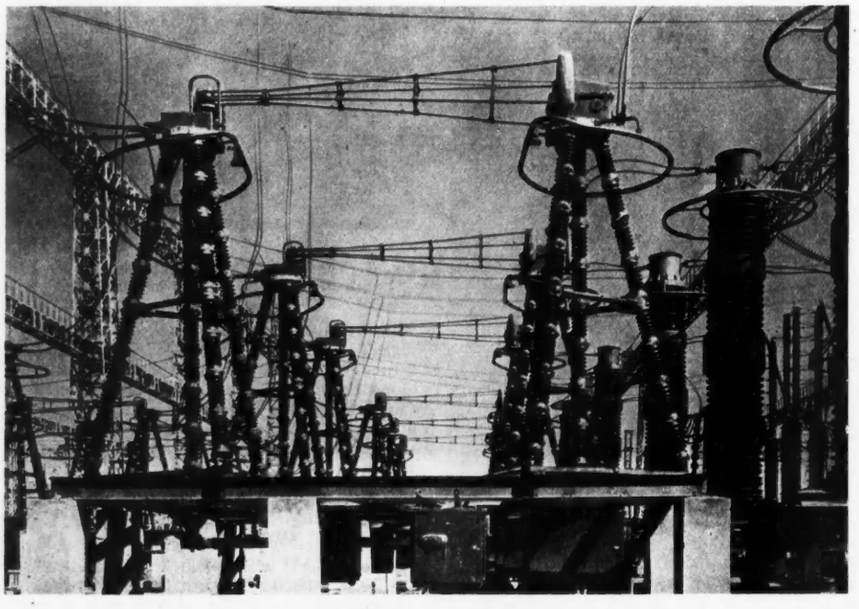
The High-Voltage D.C. Research Institute, with headquarters at Leningrad, controls two research buildings at Leningrad and an experimental transmission scheme which feeds into the Moscow system. The institute is responsible for all research on h.v. d.c. transmission, and on special h.v. a.c. transmission problems at or above 400kV.

In a subsequent general discussion the following points were noted. Approval has now been given for the construction of a high-voltage d.c. transmission line between Stalingrad and the Donbass for the transmission of 750MW over a distance of 340 miles. The circuit will be almost entirely overhead line operating at 800kV (±400kV), but, in order to gain experience, short lengths of cable may be laid at one end. The connection will operate initially as an asynchronous tie between the Stalingrad and the Donbass zones ; there will be no paralleling a.c. interconnection, and the problems of parallel operation of a.c. and d.c. connections have not yet been studied in the laboratory. The project is, in effect, a large-scale experiment to prepare the way for h.v. d.c. transmission in Siberia, where it is envisaged that it will be necessary to transmit 2,000,000kW to 4,000,000kW a distance of 1250 miles at 1000kV (±500kV). Earth return would be used in emergency only ; the connection to earth would be made by overhead line to the earth plates some 19 miles from the circuit termination. It is considered in the Soviet Union that the transmission of 700MW 310 miles represents the approximate boundary conditions beyond which d.c. is cheaper than a.c. for overhead line connection.

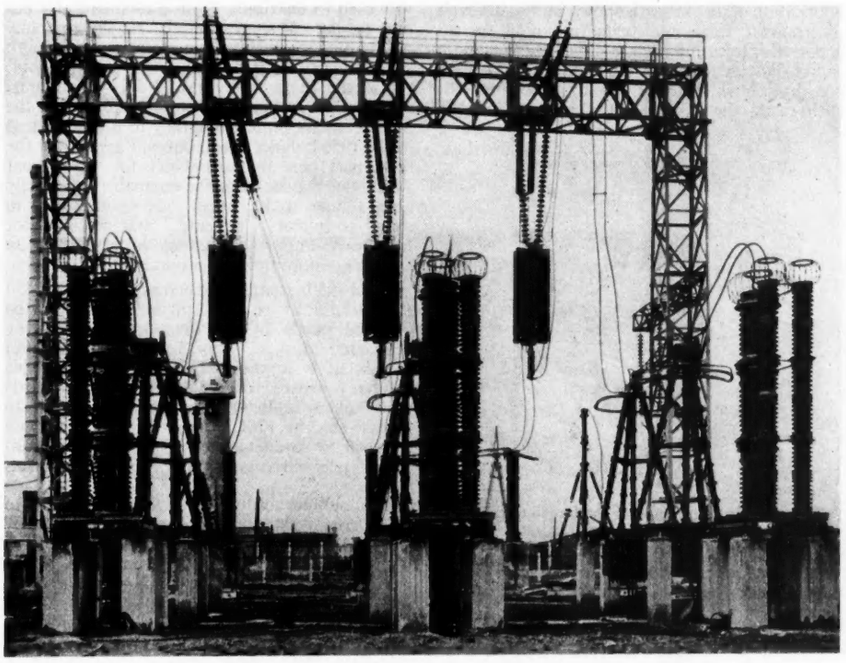
Estimated Costs of 800*kV d.c. Transmission between Stalingrad and Donbass*

	Roubles
(i) D.C. scheme as planned :	
Donbass substation equipment (including synchronous condensers)	150,000,000
Overhead line	150,000,000
Stalingrad substation equipment	80,000,000
	380,000,000
(ii) Alternative a.c. scheme :	
Substation equipment	90,000,000
Overhead line	260,000,000
	350,000,000
(iii) Alternative d.c. scheme with cable throughout :	
To (i) above add :	
For aluminium core and sheath cable... ...	250,000,000
Or for pipe type cable (aluminium core) ...	450,000,000

It is now ten years since arrangements were begun for a full-scale d.c. power transmission project into the Moscow area, and the present scheme for a connection between Kashira and Moscow was started in 1950. This connection over a distance of 75 miles is made by two cables and the arrangement is such as to permit opera-



400kV Isolators at Noginsk



400kV voltage transformers and multi-frequency line traps at Noginsk

tion at 200kV with one pole earthed or ±100kV with mid-point earthed. Overhead line conductors can be used instead of the cables, but it appeared that the majority of tests had been made using cables. Experience with the cables has been good, no trouble having been experienced with the more recent of the two designs in service. This is a solid, impregnated-paper-insulated cable, with an insulation thickness of 0·45in and a 0·232 square inch conductor formed from three heavy aluminium strands laid up under a screening tape. Overall diameter is 2·26in. Soviet engineers consider that this cable, with a breakdown stress of 1000kV to 1200kV per centimetre, and a normal maximum working stress of 300kV per centimetre, could not be considered as suitable for a.c. operation at more than 35kV, with corresponding stresses of 250kV per centimetre and 60kV per centimetre respectively. On the question of line insulation, the opinion was offered that the insulation of a line designed for 200kV a.c., three-phase, would not be suitable for more than 200kV d.c. to ground.

It was thought that the life of valves could be taken as 23,000 hours, the limitation being imposed by erosion of the auxiliary anodes. One anode and grid assembly, which had been in commission for four months, was available for inspection which revealed minor blackening of the grid and moderate burning of the tip of the anode. The valves are oil-cooled and continuously evacuated at a working pressure of 10^{-6}mm Hg. Backfires are suppressed in three to four half-cycles.

The circuit was operating at 135kV, 150A (20MW) at the time of the visit, feeding 10MW into the 110kV and 10MW into the 10kV Moscow systems by means of a double bridge arrangement. For normal working there are, as at Kashira, three rectifiers in each half of the bridge (i.e. 33kV rectifiers), but certain rectifiers were out for overhaul making reduced voltage working desirable. Ease of load control and the operation of high-speed reclosing following a fault were demonstrated, this demonstration being made possible by the continuous parallel operation of the a.c. system connection between Kashira and Moscow.

No tests have been made which involve separating a block of a.c. load at the receiving end in order to check frequency control. Reactive kilovolt-amperes amounting to 50MVAR at full load are taken from the local system, but a 30MVAR synchronous condenser is being installed to reduce this demand.

A number of valves of the type to be used on the Stalingrad scheme were under test at the time of the British visit. These valves are to be single-anode, rated at 900A. There had evidently been some trouble due to external flash-overs on the insulators of an earlier design and it was noted that the insulators on the newer units had a longer creepage surface.

Transformer and Circuit Breakers

During the visit to the Zaporozhie transformer factory, a 400kV transformer for Kuybyshev was seen as a core-and-coil assembly. The 400kV winding is a concentric winding with the high-voltage terminal connected midway down the stack. Over-voltage test conditions were understood to be 1750kV impulse and 2·5 times the working voltage. No separate ratings or reactance of the windings was obtained. The winding arrangement of the Kuybyshev transformers recalls the Swedish transformers at Harspranget, since each single-phase unit has three 13·8kV windings and one three-phase bank (3×123·5 MVA) carries the output of three 105MW generators. A notable detail of the winding construction was the use of wood for support blocks, and for terminal supports. Wooden bolts and nuts are used throughout in this supporting structure.

Tank fabrication by welding is highly developed, one instance being the use of an unattended travelling welding carriage, magnetically held on to the tank side and moving automatically along a circumferential seam. Forced oil circulation does not seem to be employed, reliance being placed on multiple nests of cooling tubes associated with headers from the main tank, and one or two fans within each nest to assist air circulation above 50 per cent full load. Winding "hot-spot" temperature indicators are not used, being considered totally unnecessary once the thermal conditions have been established during type tests. Fan motors are started and stopped by current-operated relays.

The small-oil-volume circuit breaker is used almost universally at voltages of 35kV, 10kV and 6kV. At 110kV and 220kV, use is made of both bulk oil and air-blast, but air-blast only is used for 400kV. In the choice for 110kV and 220kV substations an important factor is that the bulk-oil breaker can be directly heated and is thus the more suitable for cold regions, where temperatures may be down to −75 deg. Fah., although air-blast breakers are in service in Siberia where the cold may be of this intensity.

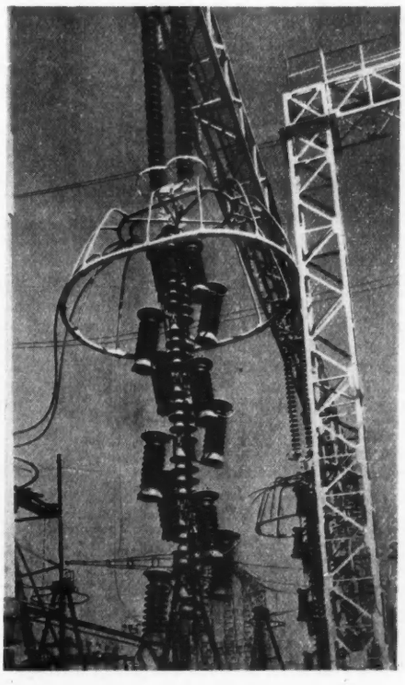
For 220kV and 400kV operation the manufacturing cost of the air-blast breaker was said to be about 30 per cent greater than that of the bulk oil breaker, without taking account of the difference in current transformer requirements.

Testing arrangements are not elaborate. Manufacturers have small plants capable of testing lower voltage circuit breakers—but probably not of the higher ratings. The Molotov Technical Institute in Moscow was understood to have high voltage and heavy current equipment, permitting synthetic tests to be made on the 110kV, 220kV and 400kV air-blast breakers, but reference was made to one design of 220kV breaker which had failed in service after successfully withstanding synthetic tests in the laboratory. Bulk oil breakers are tested only at suitable substations on the system. Consideration is being given to the establishment of high-power testing laboratories similar to those employed by British manufacturers.

At the Electroapparat factory at Sverdlovsk a new design of 400kV air-blast breaker, rated at 15,000MVA, was erected for test operation within large semi-permanent scaffolding, and operation was demonstrated. The operating pressure was 300 lb per square inch. On each phase there were eight main breaks in one vertical stack, with two parallel stacks—one containing eight auxiliary breaks with series linear resistances totalling 3000 ohms, and the other containing eight grading resistances totalling 50,000 ohms. The air storage capacity in the base of the assembly was sufficient for three make-break operations. Basic insulation levels were said to be 1200kV, 1/50 wave and 750kV, 50 cycles.

At this factory also the delegation was shown models of lenticular-type bulk oil breakers for application up to 220kV and air-blast for 400kV. On the shop floor there were cylindrical tank bulk oil breakers rated at 5000MVA at 220kV. The tanks were about 15ft high and had an oil content of 10 tons per phase. In each single-phase tank there were two arc-control devices, each consisting of two side-blast pots in one assembly about 3ft long, with one shunt resistance across each pair of pots. Bushings were made in Moscow and current transformers and voltage transformers at another works in Sverdlovsk. Operation was by solenoid at 200V.

At the Zaporozhie factory the party saw a 400kV isolating switch similar to those installed at Noginsk. Each phase consisted of two tripod insulator assemblies, one carrying the hinged end of a built-up lattice-type blade which opened in a vertical arc, and the other carried the fixed contact. A central rotating post actuated the blade through gearing; a similar rotating post in the tripod carrying the fixed contact rotated



400kV surge directors at Noginsk

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the latter to assist ice-breaking. An earthing switch of the collapsible-link design was incorporated in the assembly.

At the 400kV substation being erected at Noginsk the circuit breakers (illustrated here) were said to have a rating of 10,000MVA with an impulse level of 1500kV, and there were seven breaks in series. Extensive switching tests had shown the maximum internal over-voltage to be not more than three times the phase-to-neutral voltage. For 400 miles of line the arc from a faulted conductor to ground could be maintained for 0·3 to 0·6 second, and for this length a dead time of 0·8 second would be considered necessary in the automatic reclosing cycle. However, taking into account the shorter lengths achieved by the section stations a dead time of 0·4 second was being used. At this station the 220kV breakers were rated at 5000MVA and the 110kV breakers at 4000MVA.

Automatic reclosing of circuit breakers, following interruption due to faults, is very extensively used in the U.S.S.R. It was stated that 6715 breakers were fitted with auto-reclose features, representing 95 per cent of the total number of circuit breakers in service. Apparently three-phase auto-reclosing is applied to all 35kV and 110kV breakers and to most 220kV breakers. Single-phase auto-reclosing is applied on some 220kV and most 400kV breakers. At Noginsk it appeared that at least one section of the 400kV connection to Kuybyshev would be operated on a three-phase reclosing basis. The normal dead-time is 0·8 second, but the Noginsk exception mentioned above should be noted. Neither non-linear resistors nor capacitors are used for voltage grading on series air-blast breaks.

Clamping and Coupling Discs

A novel element for mechanically connecting concentric cylindrical components is the slotted disc developed by Ringspann Albrecht Maurer K.G., Bad Homburg v.d.H., German Federal Republic. The basic form is illustrated in Fig. 1. The "Ringspann" disc, made of heat-treated spring steel, is of slightly dished shape and provided with alternate internal and external radial slots. The clamping action is obtained by inserting one or several discs between the two components and applying an axial force tending to flatten out the discs and thereby expand them in a radial direction: One application of this nature is shown in Fig. 2, which illustrates a workpiece being mounted on an arbor prior to turning or grinding. It is generally found difficult to clamp thin-walled workpieces, e.g. in a chuck, without causing distortion. In such cases, the "Ringspann" disc provides a solution, as the disc pack applies pressure evenly over the circumference of the work so that distortion is prevented.

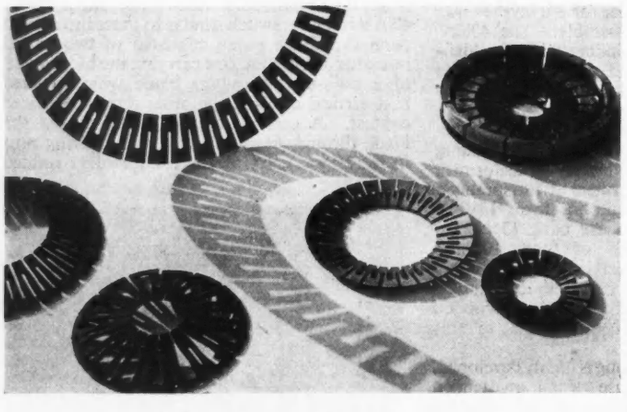


Fig. 1—Selection of "Ringspann" discs

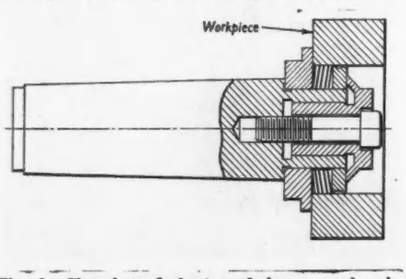


Fig. 2—Clamping of short workpiece on arbor by means of "Ringspann B" washers

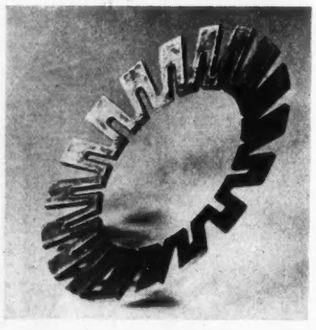


Fig. 3—"Star Disc" washer for torque transmitting assembly of mating components

The clamping disc is made in two main designs, depending on whether the variable diameter is the bore (type A) or the outside (type B). The outside diameter of the standard discs varies from about 14mm to 200mm, and the inside diameter from about 4mm to 165mm. The clamping range varies according to size from about 3mm for small discs to 10mm for the large sizes. Concentricity varies according to grade; for quality I it is given as better than 0·01mm, for quality II better than 0·04mm.

For forming torque-transmitting assemblies of mating components, such as shafts and gear wheels, pulleys, hand wheels, dials, &c., so-called "Star Discs" are available (Fig. 3), although "Ringspann A" discs can also be used for this purpose. The "Star Discs" differ from the "Ringspann" discs in the shape of the spokes, which, in the former design, are not radial, but form triangular configurations with the outer cylinder wall. In this way they are able to transmit greater torques.

The principle of the slotted disc has been applied by the maker to the construction of overload and engaging clutches, and various clamping mandrels and chucks for workpieces up to 11in diameter and over.

Agent in the U.K. is K. S. Paul, Ltd., Great Western Trading Estate, Park Royal Road, London, N.W.10.

Annual Report of Esso A.G.

The annual report of Esso A.G., Hamburg, for the period January 1 to December 31, 1956, was published last week. The company, a subsidiary of Standard Oil Company, New Jersey, is to increase its capital to DM.300, following an increase in December, 1956, from DM.138·7 million to DM.200 million. In spite of the Suez crisis, turnover increased by 18 per cent to DM.1670 (1416) million, and profits after deduction of customs duties and mineral oil tax, to DM.1239 (1047) million. In this way Esso A.G. maintained its leading position in the German market. Although operational profits increased, they were nearly all taxed away, and the net profit of DM.4·4 (9·8) million was derived from "other sources." This amount was used to distribute again a dividend of 4 per cent on the old share capital. As the company points out, the result amounts to a payment to shareholders of DM.0·26 per DM.100 profit, whilst the State took DM.27·50. The report stresses the fact that extra costs arising out of the Suez crisis are represented only to a small extent in the 1956 balance sheet, but will appear for the most part only in the balance for the current year. During the crisis the company was largely able, thanks to its world-wide connections, to meet consumers' demand, making up for temporary import reductions of crude oil by importing more finished products.

Until 1960, expansion schemes costing DM.450 million are to be undertaken, which will be financed partly by a loan. In addition, the associated firm, Esso Tankschiff Reederei G.m.b.H., is to invest DM.300 million. This company ordered in 1955 from German yards nine tankers of 36,000 tons deadweight each, to be delivered by 1961; the order has since been changed to seven tankers of 47,000 tons deadweight plus three tankers of 36,000 tons deadweight.

The number of petrol stations increased to 4600 from 4400, the number of employees by 289 to 4565. Working hours were reduced from forty-eight to forty-five on September 1.

During 1956, the Hamburg refinery achieved a throughput of over 2·1 million tonnes (+6 per cent). However, because of the crude oil shortage during November/December, output fell by 22 per cent below what had been planned. This, together with difficulties experienced with new types of crude oil, had the effect of increasing costs. Two new plants came into use in Hamburg in the year under review. One was a separation plant for propane, butane, propylene and butylene, used in the chemical industry, e.g. as solvents and for plastics. The other was a hydroformer which, by means of catalysts, produces high octane petrol from lower octane distillates. In addition, the delivery of refinery gas to the Hamburg gas works began at the end of 1956. Hamburg is to receive 75,000,000 cubic metres of gas, which is to be transformed by a cracking plant into 110 million cubic metres of town gas; this quantity is about 20 per cent of the total present consumption. Investments at Hamburg refinery during 1956 amounted to DM.21,000,000. Adjoining land to the extent of 425,000 square metres was acquired. Extensions there will increase the throughput to about 3,000,000 tonnes of crude oil by 1959.

Construction of the Cologne refinery on a site of 2·5 square kilometres began in the spring of this year. Five firms with over 200 engineers were concerned in the planning. The city of Cologne is at present constructing a basin for eight river tankers as well as a power station which will supply the refinery with electric current and steam. The plant is to go into production in 1959 with an annual throughput of 3·5 million tonnes, which is later to be increased to 7·5 million tonnes. By 1965, Esso A.G. expects to have a refinery capacity of 10,000,000 tons, or 25 per cent of the West German total.

Heavy-Duty Hydraulic Scrap Shear

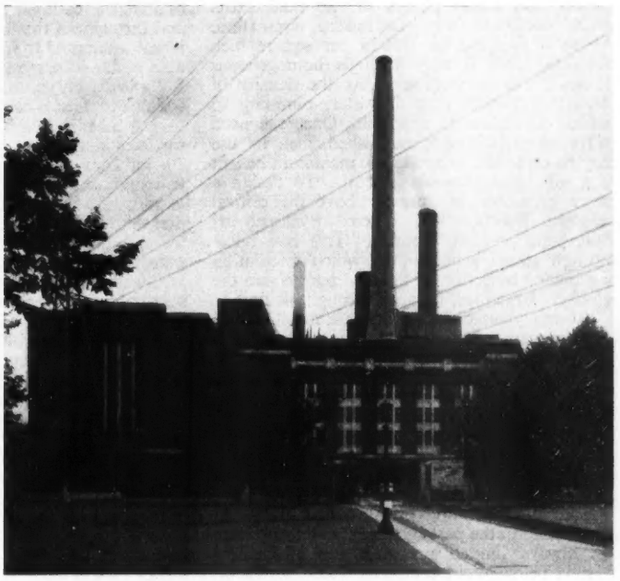
A large heavy-duty scrap shearing machine for cutting up bulky scrap such as steel sections, ship plates, &c., was recently completed at the works of Lindemann Maschinenfabrik G.m.b.H., Dusseldorf, for shipment to a firm in the United States. This hydraulic machine has a drive of some 1000 h.p., and is operated through an oil hydraulic system by twelve pumps. It is designed to exert a shearing force of 1200 tons and is equipped with four compression hold-down rams of 100 tons each. It has a shear opening 7ft wide, 48in high in the centre, the upper blade being vee-shaped and the lower blade straight.

Scrap is fed into the shears through a 40ft long feed bed by a hydraulic ram. A prefilling hopper installed at the side of this main feed bed is filled whilst the machine is in operation, ready for its contents to be transferred at the end of each shearing cycle. The manufacturers of this machine are represented in this country by Moffat and Bell, Ltd., 170, Piccadilly, London, W.1.

Philo Steam Power Station

BY OUR AMERICAN EDITOR

No. I



The 120MW super-pressure unit which went into commercial operation at the Philo power station of the Ohio Power Company in June is to-day the most advanced steam-electric generating plant operating in the United States. While initially operating at less than rated design conditions, the unit is expected ultimately to achieve a net heat rate of 8530 B.Th.U. per kilowatt-hour. The boiler has been designed to deliver steam at a pressure of 4500 lb per square inch gauge, at a temperature of 1150 deg. Fah. and at a rate of 675,000 lb per hour. The tandem compound turbine has two stages of reheat, respectively raising the steam temperature from 800 deg. to 1050 deg. Fah. at 1225 lb per square inch gauge and from 630 deg. to 1000 deg. Fah. at 185 lb per square inch gauge.

THE so-called No. 6 generating unit at the Philo steam power station of the Ohio Power Company, near Zanesville, Ohio, has been operating under test conditions since March 20 last and has now been put into commercial operation. It is to-day the most advanced steam-electric generating unit in the United States and is regarded as an important pilot scheme in the current American trend toward very high steam pressures and temperatures and large turbine sizes. The Ohio Power Company is a subsidiary of the American Gas and Electric Company, one of the leading utility concerns in the United States. In view of the importance of the present unit, it is of interest to note the following remarks by Philip Sporn, the president of American Gas and Electric, concerning the origin of the Philo development: "The remarkable record of the American utility industry in not only keeping up with the demands and needs of the country for increasing amounts of electric power during the past twelve years, but also doing so at substantially static or even declining rates in the face of a doubling or more of almost all other indices of cost in the same interval, is due to a large number of basic causes. High in order of importance among these has been the progress made in developing modern and more efficient techniques in building and operating the generation facilities. While the use of higher steam pressures, higher temperatures, reheat and higher reheat, larger units, and single boiler, single turbine unit system designs all date back to the 'thirties, the principal steps forward were all taken within the past twelve years. But it has been evident for some time that a flattening out in this curve of progress was rapidly setting in unless new avenues of approach and of progress were opened up. The more the problem was studied by the engineers of the Babcock and Wilcox Company, the General Electric Company, and the American Gas and Electric Service Corporation, the clearer it became that any significant progress now that would at the same time open up the way for further progress in the years ahead lay in breaking away from present conventional design limits and limitations in pressures, temperatures and reheat, and thus from the limitations on further reductions in capital costs of generating plant facilities. This approach has culminated in a new unit embodying many new and forward-reaching ideas in the technology of economic generation of steam-electric power which was ordered for the Philo steam power station of the Ohio Power Company. The background work for this unit includes more than thirty years of experience within the A.G. and E. system and a continuous programme of co-operation and research with General Electric and Babcock and Wilcox.

"The management of these companies decided that it was opportune to install a commercial-scale unit as moderately sized as could be practically built. This would embody the many new developmental ideas and the most advanced technology to obtain experience in the design, manufacture, construction and operation of all the equipment involved, before proceeding on and making the next large and significant step in improving steam generating station economy and economics. It is interesting and fitting that this new step toward more economical power generation should be made at the Philo station because it was there that one of the earliest steps in this direction, the installation of a 600 lb per square inch reheat unit was made in 1924. While many new concepts have been included in this developmental unit, the following are particularly outstanding:—(1) An extremely high boiler and turbine operating pressure. Both the feed-water inlet pressure of 5500 lb per square inch and the turbine throttle pressure of 4500 lb per square inch constitute not only new records in their respective classes, but are approximately double any pressures previously developed commercially. (2) A pressure well above the critical pressure of 3206 lb per square inch, thereby requiring the unit to be of the 'once-through' type, eliminating the need for the heavy and costly drums found in conventional evaporative boilers. (3) A main steam temperature of 1150 deg. Fah., 50 deg. higher than anything previously built in America. (4) A double reheat design to increase the operating efficiency. (5) A new design of feed pumps to deliver feed-water at 5500 lb per square inch."

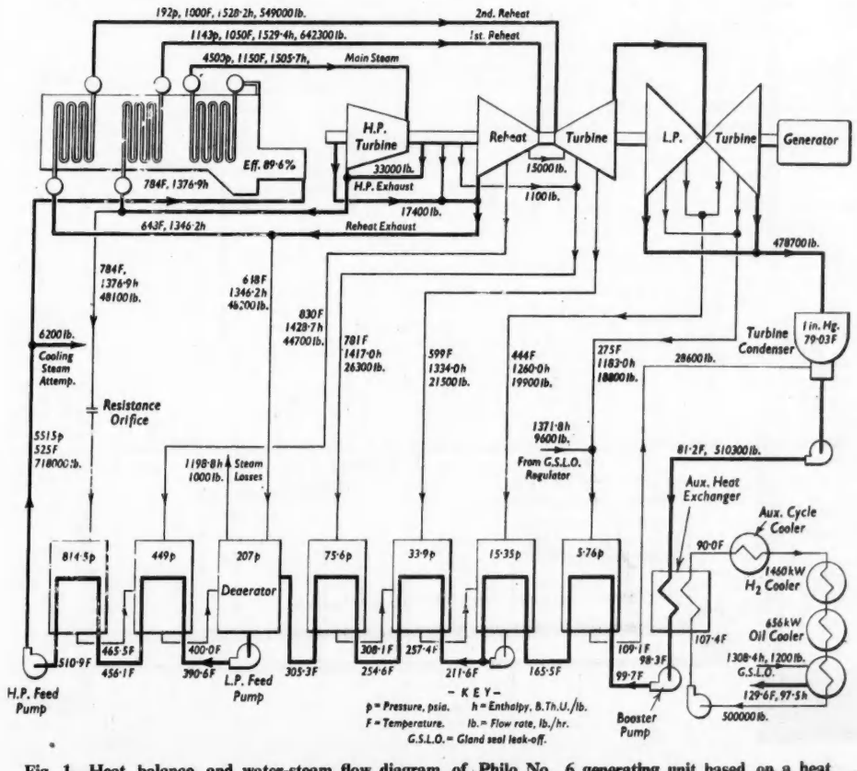


Fig. 1—Heat balance and water-steam flow diagram of Philo No. 6 generating unit based on a heat rate of 8530 B.Th.U. per kilowatt-hour

Cycle Selection

When the operating pressure in the steam cycle is raised above the present maximum standard, in the range of 2500 lb per square inch, it becomes impractical to design natural-circulation boilers. Natural circulation cannot be used above 3206 lb per square inch absolute because no difference in densities corresponding to the

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vapour and liquid phases of the fluid exists which could be used to induce circulation. Above a pressure of 3206 lb per square inch absolute, there is only a single homogeneous phase at any temperature. As the density of steam approaches that of water, pumping to induce circulation is required. Once the need of forced circulation is established, then its use may be exploited to obtain the maximum benefit at a minimum incremental cost. To design a steam generator to operate above the critical pressure, Babcock and Wilcox developed its "universal pressure" design. This is a once-through steam generator in which circulation is provided by action of the feed pumps and the relatively large pressure drop through the unit.

Thermodynamic studies indicate that for each throttle steam temperature there is a corresponding throttle pressure which gives the maximum cycle efficiency. This is apparently true, both on an ideal basis and on a practical basis where turbine efficiencies are included. The optimum pressures of the actual cycles are somewhat lower than for the ideal cycles because of the effect of decreasing turbine efficiency with decreasing volume flow. This phenomenon of optimum operating pressures has not been experienced in the past because standard practice has always limited pressures for mechanical reasons below those pressures which would be optimum for the temperatures used. It was decided that 1150 deg. Fah. represented the maximum temperature that could be achieved with materials at present available. In the present design, the builders wished to use the maximum combination of temperature and pressure justifiable, since the basic premise of the project was the close relation and interdependence of the two. An operating pressure of 4500 lb per square inch was then selected not only because of its apparent optimum relation to 1150 deg. Fah., but also because it gives operating pressures in the feed-water-heater lines, boiler, and steam lines which are within the limits of established codes. In this particular decision and throughout the design of the unit as a whole it was attempted to meet the letter of the applicable codes. In many instances this has called for excessively conservative design conditions which ultimately could be somewhat modified. The A.S.M.E. Boiler Code, for instance, calls for feed-water shut-off valves to be designed for 20 per cent in excess of design pressure at a temperature corresponding to design saturation temperature in the boiler. Attempting to interpret this requirement literally, the designers called for 706 deg. Fah. (the critical temperature of water) as the design temperature for the two big feed-water shut-off valves, even though the maximum conceivable temperature that could reach these valves by action of the feed-water heaters is approximately 575 deg. Fah.

Reheat at 1150 deg. Fah. was initially included in the design considerations to obtain the gain in cycle performance associated with reheat. Preliminary discussions with the turbine manufacturer indicated that there would be considerably more difficulty in designing a reheat stage to handle steam at approximately 1000 lb per square inch and 1150 deg. Fah. than at 4500 lb per square inch and 1150 deg. Fah. This problem arises from the larger volumes that have to be handled at the lower pressures and the resulting higher bucket stresses. A reheat temperature of 1050 deg. Fah. seemed to be more reasonable, although it reduced the cycle efficiency somewhat. This increment of efficiency was recovered, however, by the use of a second reheat which becomes feasible at the high initial pressure of the cycle. The second reheat temperature of 1000 deg. Fah. was chosen to limit the design difficulties on the first stage of the turbine following this reheat and to retain approximately 1½ per cent moisture in the exhaust of the turbine at full load. The pressures for the two reheat points were selected on the basis of optimum cycle efficiency as well as optimum boiler reheat-inlet temperatures. Realising the developmental nature of this unit, its size was not selected on the usual basis. On the one hand, the unit had to be kept relatively small so that experience could be obtained with a moderate investment; on the other hand, the unit had to be large enough to be a true prototype of future machines and to have steam-volume flows which could be utilised at reasonably high efficiencies in the early stages of the turbine. A rating of 125MW appeared to be a good balance between these effects and was selected for this machine. During all design work, decisions as to possible courses of action were guided by the desire to make this a true prototype of a larger unit having a capacity more suitable for modern requirements.

With the main and reheat steam conditions and unit size selected, a detailed heat balance was laid out. Studies indicated the optimum feed-water temperature to be about 565 deg. Fah. with the reheat pressures which were selected. The feed-water temperature to the boiler in this cycle has been limited, however, to 525 deg. Fah. by introducing an artificial pressure drop in the extraction line to the highest pressure heater. The maximum feed-water temperature of 525 deg. Fah. was selected so that the transition zone between the waterlike phase and steamlike phase of the fluid would be situated in a low-temperature low-heat-input section in the steam generator. Feed-water enters the steam generator by flowing through the three cyclones and some of their associated walls in series. Consequently, there is a certain unavoidable heat input before the water is carried to a relatively low-temperature zone in the rear of the steam generator. This heat input established the feed-water temperature limit. The restriction introduced in the extraction line of the top heater can be changed and the top heater has been designed so that it can operate at the full 565 deg. Fah. feed-water temperature. It may transpire in the course of operation that it is absolutely necessary to keep the unstable transition zone in areas of low-

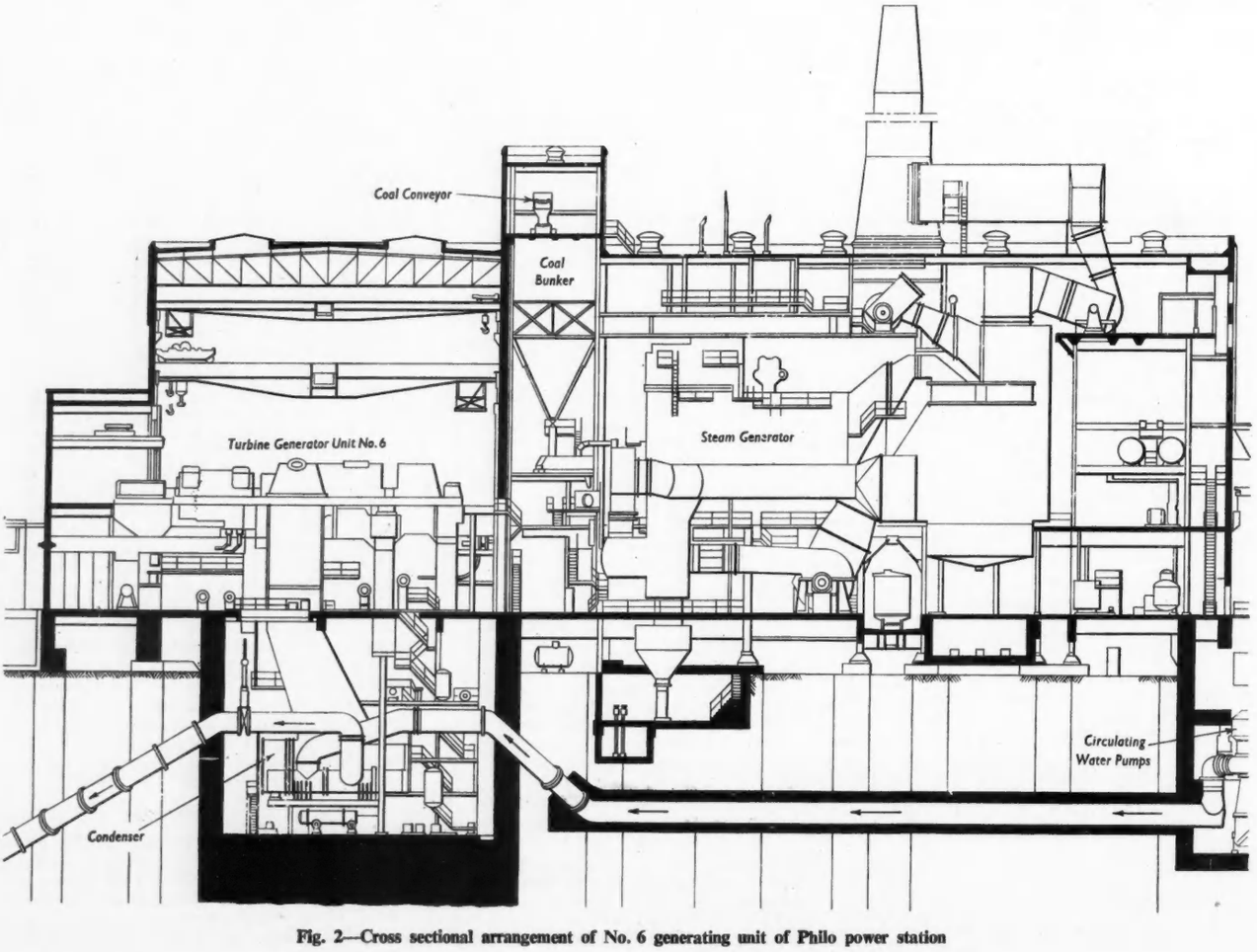


Fig. 2—Cross sectional arrangement of No. 6 generating unit of Philo power station

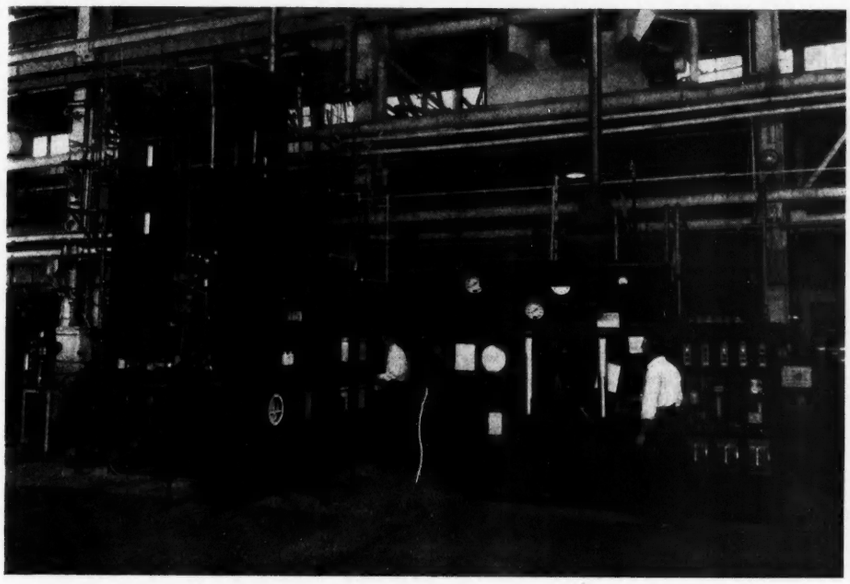


Fig. 3—5000 lb per square inch super-critical pressure pilot steam generating plant at the Babcock and Wilcox research centre in Ohio

heat input if deposits are to be avoided.

To limit oxygen in the feed-water as much as possible and thus to prevent oxide build-up, a high-quality deaerator has been included in the cycle. The location of the feed pumps normally would be directly under the deaerator to handle the smallest possible volume of fluid. The investigations indicated that conventional feed-water heater designs could not be adapted for the high feed-water pressure required and the time schedule did not permit research and development of special designs. Therefore, the pumps were split into two sections, with the high-pressure feed-water heaters intermediate, operating at 2100 lb per square inch. The arrangement of the heat balance was completed by the inclusion of other conventional items such as hydrogen coolers, oil coolers, and the G.S.L.O. condenser in the condensate cycle. The final heat balance is shown in Fig. 1, giving a heat rate of 8530 B.Th.U. per kilowatt-hour.

General Arrangement of Station

The general arrangement of Unit 6 in the station is shown in Fig. 2. The steam generator and its auxiliaries are situated in the area formerly occupied by three 600 lb per square inch standard boilers and one reheat boiler which served Unit 1. The only major structural changes required in the boiler-room were the raising of the roof in the area immediately above the steam generator proper, the strengthening of the columns carrying the steam generator, air heater, and new stack, and the erection of the new coal bunkers. These coal bunkers were situated over the front end of the steam generator to obtain easy access to the cyclones and to the existing coal-handling system. A new pit was opened in the basement floor to accommodate the slag tank and its removal equipment. Adjacent to the turbine a portion of an open pit along the north end of the station which had housed the machine shop was framed over to provide space for the control room. A small extension beyond the existing turbine-room wall was made to house the exciter and to provide space to pull the generator rotor. A small crane was provided in this area to handle the exciter and the generator rotor.

The Steam Generator

The Philo steam generator was designed and built by Babcock and Wilcox, and is rated at 675,000 lb per hour at 4500 lb per square inch and 1150 deg. Fah. with a feed-water temperature of 525 deg. Fah. There are two reheat sections ; the first was designed to raise 655,000 lb per hour at 1225 lb per square inch from 800 deg. to 1050 deg. Fah.; the second to raise 520,000 lb per hour at 185 lb per square inch from 630 deg. to 1000 deg. Fah. The unit has an estimated capability of 740,000 lb per hour at the main steam conditions. The arrangement of the steam generator consists of cyclone-fired furnaces in front of pendant superheaters and reheaters. The walls of the cyclones and the front wall of the primary furnace are cooled by incoming feed-water. The transition from water to steam occurs in the primary superheater in the coolest gas zone. The remainder of the wall and pendant surface is superheater surface. The final superheater is arranged across the width of the furnace. The convection pass is divided by a baffle with the primary superheater on one side and the two reheat sections in series on the other. The gas flow is proportioned by dampers at the outlet of each side. By control of firing rate, the main steam temperature is controlled and, by positioning these dampers, one of the two reheat temperatures is controlled. The superheater surface is arranged to provide adequate fluid temperature equalisation at the superheater outlet. The four pipes conveying steam to the turbine inlet originate at a common point in the superheater header so that they will be subjected to only small differences in temperature. To eliminate any temperature difference at the turbine, the exit from the first reheater outlet header has been made a single line of adequate length to ensure mixing and equalisation of temperature. The second reheater has four outlets, which are piped to give best mixing and are protected against severe temperature differences by an attemperator.

To avoid slagging conditions in the pendant and convection sections, flue gas recirculation is employed to limit gas temperature. Flue gas taken from the convection pass outlet at 800 deg. Fah. is mixed with hot gas at 3000 deg. Fah. from the primary furnace to reduce the gas temperatures entering the pendant sections to 1900 deg. Fah., which is below the ash fusion temperature. The design of the recirculating gas ports for most effective mixing was developed on a pilot scale model at the Babcock and Wilcox Research Centre at Alliance, Ohio. In Fig. 3 we show the 5000 lb per square inch pilot plant erected at Alliance in 1953. The pilot plant consists of a single tube, running along the walls of a brick-lined, gas-fired furnace. The gases leave the furnace through convection surface, formed by this same tube. Subsequent development extended this tube through another furnace for raising the steam temperature up to as much as 1150 deg. Fah. This set-up has permitted the exploration of the following :—(1) Properties of the fluid ; (2) pressure drop characteristics with variations in mass flow, pressure and temperature ; (3) response characteristics and the control required ; (4) heat transfer rates of the fluid film ; (5) water-conditioning requirements, and (6) internal conditions as affected by water conditions, heat fluxes, mass flows, pressures, temperatures and flow arrangements.

In a once-through steam generator, any material entering with the feed-water either must be deposited in the unit or leave with the steam. Hence, the initial phase of the water-treatment investigation consisted of short-time runs to establish the conditions which would be necessary for a successful long-time run. It soon became apparent that iron pick-up in the pre-boiler equipment was a limiting factor similar to present-day operating experience.

The tests established 0·01 p.p.m. of Fe as about the tolerable limit. This condition was best controlled throughout the complete cycle by maintaining a feed-water pH value of the order of 9·5, and it was done by the addition of ammonia or volatile amines. Dissolved solids in the feed-water were kept down to 0·25 p.p.m. by the prevention of contamination such as may be expected from condensers. It was found that the make-up water must be of the highest quality and demineralisation of part or all of the condensate must be continuous. Such water control resulted in a successful 4000-hour continuous run with no detection of any appreciable deposit. A subsequent 2000-hour run with the same water also was successful with the final outlet at 1150 deg. Fah. This test was for the purpose of watching the chemical stability and the effects upon the high-temperature alloys. As far as is known, there has been no published heat-transfer data for supercritical pressure steam, flowing through a tube. Any data available has been based on steam flow at much lower Reynolds numbers and in an annular space which was not suitable for the Philo design. The Babcock and Wilcox research group, therefore, developed an electrically heated test section of tubing, attached to the outlet of the pilot unit. This arrangement permitted the control of fluid flow through the test section at temperatures from 220 deg. to 1000 deg. Fah. and pressures up to 5000 lb per square inch. The test section consisted of a horizontal 6ft length of 18–8 stainless steel tubing, 0·300in I.D. and 0·540in O.D. Thermo-couple wells were installed at each end of the tube. A pressure gauge was connected directly upstream of the test section. Power was applied to the tube from three 40kVA transformers. The central 4ft of the test section was provided with a pair of thermo-couples and a voltage tap, spaced every 6in. It was thus possible to obtain two outside tube temperatures at each of nine locations and to determine the voltage drop across each 6in length of tube. The test section was thoroughly insulated, and four sets of surface and depth thermo-couples were installed to determine the magnitude of the radially outward heat flow.

Fluid flow and heat input could be measured to an accuracy of plus or minus ½ per cent. Data were obtained at various flow rates, temperatures and pressures with heat fluxes from 150,000 to 600,000 B.Th.U. per square foot-hour, based on the tube I.D. The film conductances obtained proved to be higher than those based on a McAdams correlation. To include a factor of safety, the Philo unit was designed based on the lower figures of McAdams.

The steam generator is equipped with a Babcock and Wilcox tubular air heater. Based on experience at the Philo plant and elsewhere the cold end section of this air heater was equipped with " Cor-Ten " tubes. " Cor-Ten " is a high strength steel developed by the U.S. Steel Corporation and has an analysis of 0·09 per cent C, 0·38 per cent Mn, 0·48 per cent Si, 0·41 per cent Cu, 0·84 per cent Cr, and 0·28 per cent Ni.

Because of the high sulphur content of the coal (4 to 5 per cent), measures have been taken to avoid fouling the air heater during periods when the inlet air temperature would drop the stack gas below its dew point. Steam heating coils have been placed in the discharge duct of the forced draught fan to raise air temperature whenever necessary. Combustion air, which also ventilates the plant, is supplied from outside through heating coils which are designed to maintain a minimum temperature of 70 deg. Fah. These coils, together with a rise through the fan of approximately 25 deg. Fah., should provide adequate safeguards against air heater fouling and serious corrosion difficulties.

(To be continued)

Personal and Business

Appointments

MR. G. R. GUEST has been appointed deputy home sales manager of F. Perkins, Ltd.

MR. J. H. JOLLY has been appointed a director of Allied Ironfounders, Ltd.

MR. S. A. A. KNOTT has been appointed a director of Charles Roberts and Co., Ltd.

DR. J. C. SWALLOW, F.R.I.C., has been nominated president of the Plastics Institute.

MR. W. H. RICHARDS has been appointed production superintendent of Marconi Instruments, Ltd.

MR. H. G. BOULLEN, A.M.I.E.E., has been appointed sales director of Lancashire Dynamo and Crypto, Ltd.

MR. H. E. SNOW and the Hon. M. R. BRIDGEMAN have been appointed deputy chairmen of the British Petroleum Company, Ltd.

MR. S. E. CLOTWORTHY and Mr. B. L. PAGE have been appointed to the council of the Aluminium Development Association.

MR. VINCENT WATKINS has been appointed a director of Steel, Peech and Tozer, a branch of the the United Steel Companies, Ltd.

THE BOARD OF TRADE has announced the appointment of Mr. W. R. Black as chairman of the National Research Development Corporation in succession to the late Sir Alan Saunders.

THE BRITISH BROADCASTING CORPORATION has announced that Mr. M. Clough has been appointed engineer-in-charge of the new television transmitting station at Rosemarkie, Invernesshire.

MR. R. J. CARTER has been appointed a special assistant to the managing director of E. B. Badger and Sons, Ltd., a British subsidiary of Stone and Webster Engineering Corporation, Boston, U.S.A.

ASSOCIATED BRITISH ENGINEERING, Ltd., has announced that Major-General Wilfred George Fryer, M.I.E.E. has been appointed deputy chairman of its subsidiary company, the Free Piston Engine Company, Ltd.

BIRMID INDUSTRIES, Ltd., has announced that Mr. W. J. Sully and Mr. W. C. Jordan have been appointed directors. Mr. A. E. Pearce and Mr. H. Goodwin have retired from the board of directors. Mr. J. W. Berry has been appointed deputy managing director.

GIRLING, Ltd., announces the appointment of Mr. M. W. Kendall as vice-chairman and managing director. Mr. Kendall, who is at present chief engineer and a director of Joseph Lucas (Electrical), Ltd., succeeds Mr. Alex. Fraser, who has retired after thirty-one years' service with Girling, Ltd.

THE CENTRAL ELECTRICITY AUTHORITY has announced that Mr. P. W. Cash, M.I.E.E., system design and development engineer, has been appointed system operation engineer at headquarters. It has also announced the appointment of Mr. A. E. Hawkins, A.M.I.E.E., as system planning engineer to the Authority.

RUSTON AND HORNSBY, Ltd., states that Mr. P. F. Dilnot, A.M.I.Mech.E., has been appointed assistant chief engineer (marine) in charge of the marine engineering department. Other appointments in the department are : Mr. H. Bayes, marine application engineer ; Mr. A. J. Bescoby, marine installations engineer ; Mr. R. L. Rawlings, marine technical engineer.

ASSOCIATED BRITISH OIL ENGINES MARINE (MIRRLEES), Ltd., announces the following appointments :—Mr. G. W. Thwaites, A.I.Mar.E., sales manager ; Mr. M. W. Dunham, London manager ; Mr. R. S. Bickerton, A.M.I.Mech.E., area sales engineer for Liverpool and the Northwest Coast ; and Mr. A. A. Adley, area sales engineer for Hull and district. Mr. G. E. Cook has been appointed to succeed Mr. Thwaites as the company's representative in the North Coast area.

Business Announcements

MONO PUMPS, Ltd., has opened an office, for Northern Ireland, at 77, Great Victoria Street, Belfast.

LIMIT ENGINEERING GROUP, Ltd., has acquired a factory at Bletchley, Bucks, for the production of electric motors.

THE HARLAND ENGINEERING COMPANY, Ltd., and HARLAND DRIVES, Ltd., have acquired a controlling interest in Simon Equipment, Ltd.

GEORGE KENT, Ltd., has opened a new showroom devoted to industrial instrumentation at 199-201, High Holborn, London, W.C.1.

THE TURNER MANUFACTURING COMPANY, Ltd., Villiers Street, Wolverhampton, has formed a subsidiary, entitled Hydraulics and Pneumatics, Ltd., to manufacture hydraulic and pneumatic equipment for general industrial requirements.

TAYLOR-SHORT AND MASON, Ltd., states that it has undertaken a reorganisation and has formed a new subsidiary company, Short and Mason, Ltd., Aneroid Works, 280, Wood Street, Walthamstow, London, E.17, which will handle the scientific and meteorological instrument business. The name of the main company has been changed from Taylor-Short and Mason, Ltd., to Taylor Controls, Ltd., Forest Works, 75, Hale Road, Walthamstow, and this company will continue to handle all industrial instrument and control business.

Contracts

A.P.V.-PARAMOUNT, Ltd., Crawley, Sussex, has received a contract for steel castings to be incorporated in nuclear reactor plant, by the General Electric Company, Ltd. (Atomic Energy Division).

THE EASTERN REGION OF BRITISH RAILWAYS has placed a contract with Brightside Heating and Engineeering Company, Ltd., Don Road, Sheffield, 9, for boiler plant, heating system, oil storage equipment and piping at the engine repair shop, Stratford.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., has received contracts, valued at about £160,000, from the Independent Television Authority for the transmitting equipment for four new stations. One set of equipment will be installed in the Chillerton Down (Isle of Wight) transmitting station, which is planned to come into service next summer. The other three have been ordered as part of the long-term plans of the Authority, and it is likely that they will be installed in stations to be opened in North-East England, the Cumberland area and Northern Ireland.

Miscellanea

RESEARCH AND MANAGEMENT.—Some preliminary details of a conference on "Research and Better Management" have been issued by the British Institute of Management, 80, Fetter Lane, London, E.C.4. This conference is to be held at Bournemouth from November 6 to 8 next.

INSTITUTE OF ROAD TRANSPORT ENGINEERS.—The Institute of Road Transport Engineers has established a Southern Centre which is to cover membership in the counties of Dorset, Hampshire and Sussex and those parts of Surrey and Kent lying south of a line joining Guildford, Reigate and Gravesend. The Isle of Wight and the Channel Islands are also included.

COMBUSTION ENGINEERING ASSOCIATION.—The Combustion Engineering Association is arranging a conference at the Old Swan Hotel, Harrogate, on November 5 and 6 next. The purpose is to examine the third annual report of the National Industrial Fuel Efficiency Service, and to discuss the findings of the N.I.F.E.S. engineers arising from their work with various industries.

TANK LINING TECHNIQUE.—We are informed that Corrosion, Ltd., 16, Gloucester Place, Portman Square, London, W.1, in conjunction with Coltrate, Ltd., has developed a new technique for the lining of process and storage tanks with plastic linings *in situ*. The method includes the vacuum shot-blasting of the surface to be covered and the heat curing of the lining to give a hard, durable, strongly adhering, chemical-resisting and inert film.

SHIPBUILDING CONFERENCE.—Statistics published by the Shipbuilding Conference show that orders for 71 ships of 590,000 tons gross were placed with British shipyards in the second quarter of the year, making the total of new orders, up to June 30, 161 ships of 1,190,000 tons gross, 47 and 38 per cent of which are oil tankers and cargo ships respectively. These contracts bring the order book up to 879 ships of 6,952,000 tons gross, of which 22 per cent is for foreign account and 52 per cent represents oil tanker tonnage ; the estimated value is £955 million.

NON-DESTRUCTIVE TESTING.—The British Council has announced a study course on "Non-Destructive Testing of Materials," which is to be held in London and the provinces from February 9 to 22, 1958. This course is being organised solely for overseas industrial technologists and university research workers in science and engineering, and will consist of a series of lectures, discussions and visits. The main emphasis will be on the scientific background of non-destructive testing, and the method of treatment of this aspect of the subject has been so chosen as to show the progress which is being made by industry in employing relevant scientific knowledge for establishing systems of quality control and for developing automatic processes.

COMPETITION FOR FORESTRY MACHINES.—A competition to encourage the production of new machines to help those engaged in forestry is being promoted by the Royal Agricultural Society of England. The Society is offering silver and bronze medals for new or improved machines for the conversion of conifer thinnings after felling. Among the purposes envisaged are cross-cutting and/or peeling poles of not less than 3in nor more than 10in butt diameter, for pit props, and chipping machines for the conversion of poles for wood pulp and other uses. Entries of any other kind of machine for the conversion of thinnings into saleable form will be considered. In making awards the judges will consider the price of the machine ; rate of output per man-hours employed ; mobility ; mechanical reliability ; power required ; the quality of work, and suitability of the end product. All machines must be capable of being taken into forest clearings and of being easily transferred from one location to another by a "Land Rover" or light farm tractor. Provisional entries are required by March 31, 1958, and final entries by July 15, 1958. Each entrant will later have to demonstrate his appliance to the judges on a site chosen by the Society. Awards will be made before July, 1959, and the winning exhibits displayed at the Royal Show at Oxford that month.

PURE JET VERSUS ADVANCED ENGINES.—The Summer, 1957, issue of the *Bristol Quarterly* presents a comparative study of four types of engine for transport aircraft, pure jet, ducted fan, turbo-prop and "supercharged" turbo-prop. All designs are assumed to have two turbines, with entry temperatures of 1150 deg. Kelvin (cruise) and 1220 deg. Kelvin (take-off) for shaft power plants and 1000 deg. Kelvin (cruise) for the jet ; the ducted fan was driven at $0{\cdot}5g$ l.p. line speed and had both compression and augmentation ratios of 2. Propeller efficiency is taken as 91 per cent up to 400 m.p.h. t.a.s., falling to 71 per cent at 600 m.p.h. t.a.s. Fuel consumption per pound thrust per hour, installed weight per pound thrust, and the ratio of take-off thrust (at 100 m.p.h.) to cruise thrust at the tropopause are then plotted. The turbo-prop engine appears, as would be expected, more economical, heavier, and with far lower thrust at high speed. Particularly interesting, in view of the earlier comparison of pure jet and by-pass engines on a basis of equal air consumption (see page 494, October 5, 1956), is the relation between ducted fan and pure jet ; per pound thrust, the ducted fan is sensibly more efficient, but seriously heavier, comparing less favourably at higher speeds—the pure jet is the only engine to gain cruise thrust with speed. Unlike the earlier article, the present treatment extends to the operation of hypothetical aircraft. This is carried out on the basis of some remarkable empirical results ; that the fuel, engines and payload represent 60 per cent of the all-up weight, the thrust is 22 per cent of the weight at take-off, the cruise is carried out at 220 m.p.h. e.a.s., and a lift/drag ratio of 16. These figures are the result of take-off distance and regulatory requirements, and apply to contemporary propeller-driven machines and the D.H. "Comet." Direct operating costs per ton-mile are then examined for still air ranges of 2000, 4000 and 6000 miles—continental, intercontinental and trans-oceanic operation. In all cases the turbo-prop is cheapest at low speeds, but the "supercharged" engine is cheaper still at a higher speed ; at 4000 miles the jet is least costly above 540 m.p.h., and at 2000 miles it is highly competitive above 520 m.p.h. (This last finding confirms other recent estimates, but it should be noted that the jet must fly at a much greater altitude, and also that the size of the aircaft has not been stipulated.) It is realised that the cruising speed is unrealistically low for modern jet aircraft and a plot for cruising at 270 m.p.h. e.a.s. is given for 4000-mile ranges ; in this case the ducted fan takes precedence over the "supercharged" turbo-prop at higher speeds. It is observed that a ducted fan could be developed from a turbo-prop engine, and that it shares with the "supercharged" engine the ability to deliver large quantities of air for blown or jet props. It is surmised that the use of such devices to ease the landing and take-off problems may lead to the high cruising speeds that justify the, probably, higher maintenance costs of the ducted fan.

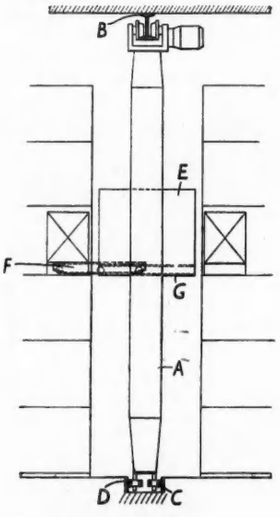
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

CRANES AND LIFTING APPLIANCES

777,989. January 31, 1955.—A STACKER, Demag-Zug G.m.b.H., Wetter-Ruhr, Germany.

The invention relates to stackers in which a load-receiving device is raised and lowered in or on a vertical framework, the framework being either suspended from a trolley movable along guide rails, or mounted on a vehicle. Stackers of this kind are particularly suitable for filling shelves in warehouses. In the drawing, the supporting framework *A*, which is constructed as a conveyor, is movable along the horizontal rail *B*. The lower part of the conveyor is provided with guide means *C*, which co-operate with guide faces *D*, provided on the floor of the warehouse, thus preventing oscillation of the framework and affording stability. The carrier *E* is constructed so as to form a support for the load-receiving device *F*, and is vertically displaceable between the vertical members of the framework by operating a winch through cables, which are connected to the load-receiving device by brackets. The carrier *E* is provided with rails *G*, of U-section, on which the load-receiver *F* is horizontally movable in both directions. The two ends of the load-receiver are of the same construction



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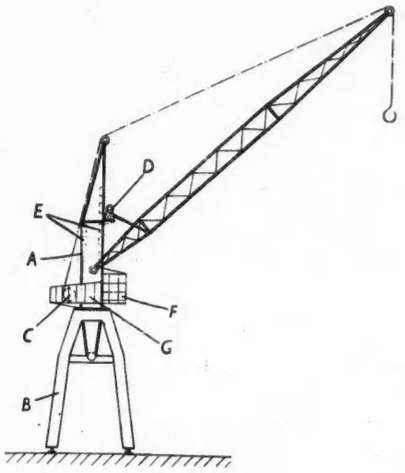
so that it is readily adapted to move in opposite directions. The width of the load-receiver is so determined—viewed in the direction of its movement—as not to exceed the width of the carrier, so that the passage between the shelves to be filled need not exceed the width of the carrier. Instead of the load-receiver being mounted on rollers, it may also be freely suspended from the carrier. Several load-receivers may be provided side by side, or one above the other on a common carrier, being, however, displaced independently of each other. In this way it is possible for an increased number of crates to be successively deposited or received, and to be simultaneously transported. By means of safety devices, provision is made for the framework to be displaceable only when the load-receiver *F* is in a mid-position relative to the carrier *E* in which it is automatically held.—*July* 3, 1957.

778,833. July 20, 1955.—PORTAL CRANES, Maschinenfabrik Augsburg-Nurnberg A.G., Nurnberg, Germany.

The invention refers to a portal crane having a pillar which can be rotated about a vertical axis so as to slew the crane, and crane actuating mechanism outside the pillar. Owing to the increased requirements for the capacity of modern rotating cranes, it has been found necessary to increase the electrical control apparatus, and its accommodation has caused considerable difficulties. The drawing illustrates one embodiment of the invention. A rotatable pillar *A* is supported in a known manner on a portal *B*. Outside the wall of this pillar the crane actuating mechanism of the crane—for instance, the lifting winch *C* and the luffing winch *D*—are accommodated. Electrical control apparatus *E*, comprising, for instance, resistances and contactors, for controlling the crane actuating mechanism, is arranged inside the rotating pillar. If also the driver's cabin *F* of the crane is accessible from the hollow inside of the pillar *A*, it is convenient to arrange all parts of the control apparatus *E* which are not directly operated by hand above the opening leading into the driver's cabin. The space accommodating the control apparatus can be separated for this purpose from a part *G* of the



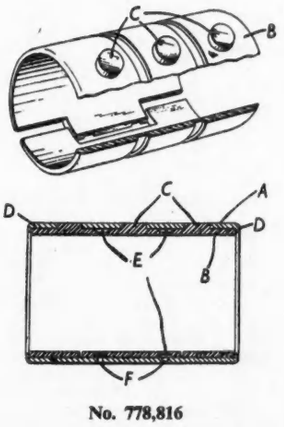
No. 778,833

hollow space of the pillar by a flap which, if necessary, can be shaped so that a person can climb through it, and is not shown in the illustration. For the maintenance of the parts of the control apparatus *E*, arranged next to each other and one above each other, the inside space of the pillar *A* above the flap can be divided into two or more storeys. The arrangement of the control apparatus above the driver's cabin and the hollow space of the pillar behind the lower part of the cabin does not exclude the arrangement of certain other parts of the control apparatus inside the hollow space if this should be found necessary.—*July* 10, 1957.

BEARINGS AND SUPPORTS

778,816. February 1, 1955.—BEARINGS, Howard Clayton-Wright, Ltd., Wellesbourne, Warwick. (*Inventors: Bernard Francis Martin and Graham Howard Clayton-Wright.*)

According to the invention there is provided a bearing assembly for two relatively rotatable members incorporating a plastics bearing liner disposed between the members and in the form of a split sleeve, the sleeve being keyed, or otherwise fixed, to the stationary member of the two, in such manner as to leave the operative bearing surface of the liner smooth and uninterrupted with the exception of the compensation gap provided by the split formation of the sleeve, and also allowing the two ends of the liner, bounding the slit, to move circumferentially to accommodate dimensional change in the liner. Referring to the



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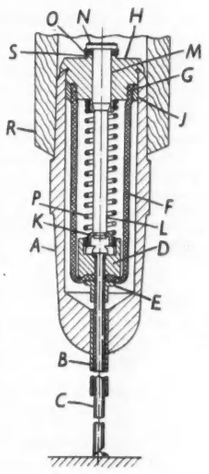
bearing assembly shown in the drawing, the outer shell is shown at *A* and the nylon liner *B* is of corresponding length. In this case the liner is provided with three upstanding bosses *C* on its outer surface and, in the assembled bearing these bosses are engaged in holes drilled in the outer shell and the ends of the shell are turned over to form lips *D*. As, in this case, the liner is retained in the shell by bosses, there is no necessity for the lips for retaining purposes and in certain applications they may be omitted, such as, for example, when the bearing is working in a gearbox where it would be running in lubricant and lubricant retention in the bearing is not therefore necessary. In this case the oil grooves are provided in the outer face of the liner *B* as circumferential grooves *E* and the shell *A* is provided with two oil holes *F* communicating with the grooves *E* when the bearing is assembled. As there is communication between the two oil grooves via the compensation gap only one oil hole may be used if desired, communicating with one of the oil grooves or with the gap.—*July* 10, 1957.

LUBRICATING DEVICES

778,420. December 20, 1954.—PRESSURE-ACTUATED OILER, V. Meylan and Fils, 4, Rue de la Savonnerie, Renens, Switzerland, and Jean Pierre de Trey, 83, Avenue C.F. Ramuz, Lausanne, Switzerland.

Known oilers of the type described have the disadvantage that it is impossible to remove an oil drop by suction through the capillary tube once it has been dispensed. It is an object of the invention to provide an oiler that enables oil to be removed by suction. Referring to the drawing, a hollow body *A* is inserted into the end of a holder, not shown, and the free end of the body is provided with a guide bush *B*. A longitudinally displaceable capillary tube *C* is supported in the guide bush *B*, the end of the tube being in the body, and carrying a bush *D* and a flange *E* between which a cylindrical flexible chamber *F* is attached to the delivery tube, the chamber being formed of a deformable plastic material. The open end of the chamber is attached between the shoulder *G* of a plug *H* closing the body, and a ring *J*. Centred in the bush *D* over a yoke extension *K* is one end of a valve plunger *L*, while the other end is provided with an elongated cylindrical valve seat *M* and a plate head *N*. The head co-operates with the conical face of the shoulder *G* of the plug *H* through a seal *O* formed of elastic material, while the valve seat *M* co-operates with the valve bore in the plug *H* in which the valve plunger *L* is centred and supported between the plug *H* and the extension *K*. If oil is to be dispensed, the delivery tube *C* is applied to the point to be oiled, and the oiler is depressed so that the resulting deformation of the flexible tube *F* partially displaces and forces oil out of the tube. With a displacement less than the length of the valve seat *M* the connection between the tube *F* and the oil container remains closed. When the oiler is lifted off the point to be oiled, the discharge tube returns to its original position under the pressure of the spring *P*. According to whether the face of the discharge tube *C* rests fully or partially on the point to be oiled, oil or air is drawn into the discharge tube, when the flexible tube *F* returns to its original shape. When the displacement is greater than the length of the valve seat *M*, an annular passage is formed between the oil container in the holder and the flexible tube. The pressure of the oil in the container and the pressure of air admitted through a small hole in the hand grip *R*, respectively act on the oil held in the flexible tube *F* so that the oil will be dispensed without further deformation of the flexible tube. A corresponding amount of oil simultaneously flows into the flexible tube from the oil container, until the valve between the two parts is closed, when the oiler is lifted off. Since the valve formed by the valve seat *M* is closed prior to the completion of the return movement of the flexible tube *F* into its normal position, oil will be drawn into the flexible tube from the oiling position through the tube *C*. The seal *O* between the plate head *N* and the conical face of the shoulder *S* is resiliently deformed by the action of the spring *P* in the sealing position of the valve plunger *L* and thereby produces an air and liquid-tight closure, so that the oil held in the flexible tube cannot be dispensed accidently owing to the capillary action of the discharge tube.—*July* 10, 1957.



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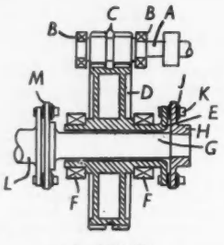
POWER TRANSMISSION

778,856. September 8, 1954.—REDUCTION GEAR TRANSMISSION DRIVES, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2. (*Inventor : Stephen Arthur Couling.*)

The invention relates to single- or double-reduction gearing for electric motors driving winding and like drums. In such drives, it is necessary to allow for considerable relative movement between the motor which is solidly mounted on its support and the drum which is liable to torsional and lateral deflections. Some flexibility in the gearing is thus required. The object of the invention is to provide this desired flexibility while maintaining economy in space of the gearing. Referring first to the arrangement shown in the drawing, a single input shaft *A* is driven from any



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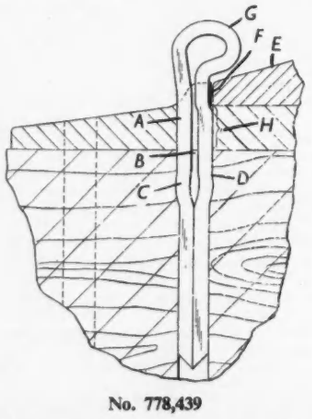
suitable prime mover. The input shaft is supported in bearings *B* and carries a high speed input pinion *C* in engagement with a low speed output gear wheel *D*. The output gear is located on a hollow quill shaft *E* in bearings *F* forming part of the gearbox. In the centre of the hollow shaft *E* is a torsion shaft *G* which is flexibly coupled by a flange member *H* through the intermediary of a resilient coupling in the form of bushes *J*, e.g. of rubber, surrounding pins *K* which transmit the drive. The end of the torsion shaft *G* remote from the input shaft is flexibly connected to the output or driven shaft *L* through a flexible coupling *M*. By reason of the incorporation of the flexible couplings *J* and *M*, and the presence of the torsion shaft *G*, considerable relative movement between the prime mover connected to the input shaft *A* which is solidly mounted on its support and the winding drum which is mounted on the output shaft *L* is permitted. The input high speed pinions *C* and the low speed output gear wheel *D* are shown as provided with two sets of gear teeth ; these may be, and preferably are, of the double helical type. Where two input shafts are required, a second input shaft may be arranged with input pinions engaging the slow speed output gear wheel *D* at another position on its periphery. A double reduction driving arrangement is also shown in the specification.—*July* 10 1957.

RAILWAY ENGINEERING

778,439. July 15, 1955.—FASTENING SPIKES FOR RAILWAY TRACKS, Lockspike, Ltd., Cory Buildings, 117, Fenchurch Street, London, E.C.3.

The invention relates to fastening spikes for use in the laying of railway tracks, and is concerned with a resilient rail spike for use in the gauge hole of a railway base-plate spike to secure the base-plate on a railway sleeper. It will be seen from the drawing that as the spike is driven there is a lateral compression of the spike in the region immediately below the head as



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the resistance of the base-plate at the walls of the gauge hole *A* force the resilient legs of the spike toward each other. With the form of spike shown there remains a gap *B* between the legs of the spike. The angularity of leg *C* in this region causes a wedging action against the walls of the hole, to produce a positive gripping action of both laterally and vertically directed forces and a firm engagement of the spike with the base-plate. In order to prevent direct contact of the leg *D* of the spike with the edge of the rail flange *E*, the leg is off-set to provide a rebated region *F* immediately adjacent the head *G* of the spike. This rebating is sufficient in length substantially to space the leg *D* from the flange while allowing for substantial spacing of the spike head above the upper surface of the rail flange when the spike is fully driven. It is not so long as to impair the wedging action in the region *H* in which both legs of the spike are in contact with the walls of the spike hole in the base-plate. Since the depth of the sleeper and of the rail flange are generally fixed, and the dimensions of the base-plate spike holes are also fixed the upper region of the spike, including the dimensions, stiffness and spread of the spike legs, the angularity of the inclined leg or legs and the dimensions of the rebated region *F* of leg *D*, are arranged so that when the spike is fully driven it will be in the position shown. The wedging of the spike in the base-plate is then so firm that the entire base-plate can be lifted by its engagement with just one spike. Modified designs are also shown in the specification.—*July* 10, 1957.

Technical Reports

Oscillations of Dielectrics and Plasma (Ref. L/T337). by H. Pelzer. The British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey. Price 7s. 6d., postage 4d.—The longitudinal oscillations of an infinite plasma or dielectric medium have an angular frequency ω, which is known as the plasma frequency in the former case, given by $\varepsilon(\omega)=0$, where ε is the dielectric constant. Finite shapes of dielectric or plasma can oscillate, but not radiate, at the plasma frequency since the field outside them is zero for all modes oscillating with this frequency ; they do, however, radiate a line spectrum of frequencies other than the plasma frequency. This spectrum is discussed for the case of a sphere and it is shown that there result dipole oscillations of a frequency given by $\varepsilon(\omega)=-2$ and higher multipole oscillations given by $\varepsilon(\omega)=-(n+1)/n$. Thus a spherical plasma will radiate a line spectrum of frequencies which are below the plasma frequency by factors ranging from $1/\sqrt{3}$ for homogeneous dipole oscillations to a limit of $1/\sqrt{2}$ for the highest multipole oscillations. In recent experiments with a spherical plasma Gabor and his collaborators did actually observe a frequency lower than the plasma frequency.

The nature of the oscillations in a body of finite shape corresponding to any initial state of polarisation is also discussed for a sphere. If the dielectric possesses more than one resonance frequency then the initial polarisation and its rate of change do not determine the state of oscillation, and the higher time derivatives of the initial polarisation must be known as well.

The vectors **D** and **E** (the electric displacement and field respectively) are not, in general, parallel even for the homogeneous isotropic dielectrics discussed here. It is shown that the whole range of negative dielectric constants from 0 to $-\infty$ (the region of "metallic reflection" of the dielectric) can be physically realised, for example, by homogeneous oscillations of ellipsoids of different shapes.

Darwin has shown that the Lorentz internal field does not apply to plasma. Here a different argument is given to show that the Lorentz field must necessarily cease to apply to a dielectric if the force which restores the charged particles to their equilibrium position is sufficiently weak. If this condition is reached the medium ceases to be a dielectric and becomes a plasma or metal.

Recherches sur la Combustion d'un Mélange d'Hydrocarbures. By J. Rappeneau. Publications Scientifiques et Techniques du Ministère de l'Air, No. 318. Service de Documentation et d'Information Technique de l'Aéronautique, Magasin C.T.O., 2, Avenue de la Porte-d'Issy, Paris (15e). Price 1100 francs.—In the present paper an investigation is described of the combustion in air of a mixture of hydro-carbons, viz. paraffin oil. After a theoretical treatment of the temperatures of combustion and the concentration of the combustion products (without considering dissociation), the part played by dissociation is examined. Temperatures and concentrations of constituents are calculated as functions of the air/fuel ratio. A combustion process is defined on the basis of the analysis of the combustion products, the fuel/air ratio and the combustion temperature. These quantities may be obtained, and the results show not only how combustion proceeds, but permit an explanation of the combustion of kerosene. The thermal character was demonstrated of the formation of nitrous oxide. Tests of a kerosene burner, consuming completely vaporised mixtures, showed the relations between the air/fuel ratio and laminar and turbulent propagation velocities, as a function of Reynold's number.

Opérateurs Symboliques. By H. Pailloux. Publications Scientifiques et Techniques du Ministere de l'Air, No. 317. Paris : Service de Documentation et d'Information Technique de l'Aeronautique, Magasin C.T.O., 2 Avenue de la Porte d'Issy, Paris (15e). Price 880 francs.—A slightly modified definition of a symbolic linear operator is given which makes the operator more versatile. By means of the notion of a generating function it is readily possible to establish its classical properties, and do it more systematically. A Laplace differential equation can be reduced to an equation with constant generalised coefficients. After a study of several individual operators, the systematic study of linear differential equations with constant coefficients is begun, and the results are applied, e.g. to recurrent sequences, difference equations (interpolation of factories) and the Fibonaci sequence.

The Mechanism of Uniform Field Breakdown in Hydrogen (Ref. L/T335). By A. Wilkes. The British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey. Price 6s., postage 4d.—Measurements with the object of checking the streamer theory over a wide range of values of *pd*, the product of gas pressure and gap length, have been continued and are described in this report. Earlier results showed that the Townsend theory of breakdown (involving (i) a primary ionisation process in the gas denoted by the Townsend coefficient α and (ii) a secondary process here denoted by γ probably taking place at the cathode), is adequate to explain the initiation of breakdown in both air and nitrogen up to a value of *pd* of about 1000cm mm Hg. Results in air lend support to this view, and in this report the results of similar experiments in hydrogen are given.

Launches and Trial Trips

STANVAC LIRIK, oil tanker ; built by the Chantiers de la Seine Maritime for the Petroleum Shipping Company ; length overall 425ft, length between perpendiculars 405ft 10½in, breadth moulded 66ft, depth 29ft, draught 22ft 6¾in, deadweight 10,850 tons, loaded displacement 14,620 tons ; eight centre tanks and eight wing tanks, two pump rooms ; two 125kW turbo-generators, one 50kW diesel-driven emergency generator ; two Nordberg F.M.D. 138 H.S.C. supair thermal, four-stroke diesel engines, each 1830 h.p. at 525 r.p.m., Messian reduction gear. Trial, May.

ARTHUR STOVE, cargo ship ; built by the Forges et Chantiers de la Mediterranée (la Seyne) for Lorentzens Skibs. A/S Norway ; length overall 490ft 2in, length between perpendiculars 458ft 5in, breadth moulded 64ft, depth to main deck 39ft 5in, draught loaded 27ft 9in, deadweight 13,000 tons, trial speed 14·5 knots ; four holds, two 10-ton and ten 5-ton derricks, electric deck machinery, three 200kW diesel-driven generators ; machinery aft ; La Seyne-Sulzer mark 8SD72 diesel engine, 5600 h.p. at 125 r.p.m. Trial, May.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Tues., Aug. 6.—S.E. LONDON BRANCH : Eltham Congregational Church Hall, Court Road, London, S.E.9, "Cables," E. D. Beckford ; "Electro-Luminiscent Lamps," H. W. Windebank, 7.15 p.m.

Wed., Aug. 7.—MANCHESTER BRANCH : Engineers' Club, Albert Square, Manchester, Film Night, 7 p.m. ★ N. LONDON BRANCH : "Queen's Head," 677, Green Lanes, Harringay, London, N.4, Film Show, 7.45 p.m. ★ HALIFAX BRANCH : Crown Hotel, Horton Street, Halifax, General Discussion, 7.15 p.m.

INSTITUTE OF THE MOTOR INDUSTRY

Sat. to Sat., Aug. 24 *to* 31.—St. Catharine's College, Cambridge, Eleventh Annual Summer School.

INSTITUTION OF MECHANICAL ENGINEERS

Sat., Aug. 31.—S. BRANCH : Whole-day visit to the pumping stations of the Mid-Wessex Water Company, Frimley, Surrey.

Sat., Sept. 14.—SOUTHERN BRANCH : Whole-day visit to the Greenham Common base of the United States Air Force, Newbury, Berks, 10 a.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY

Thurs., Oct. 10.—Mining and Technical College, Wigan, Annual General Meeting, 3.30 p.m.

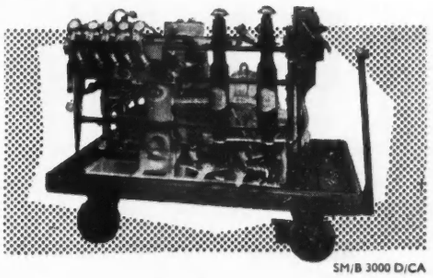
SOCIETY FOR WATER TREATMENT AND EXAMINATION

Wed. to Fri., Oct. 2 *to* 4.—Palace Hotel, Southend-on-Sea, Autumn Meeting, 1957.

Drying Compressed Air for the "Britannia"

Wing flaps, undercarriage and servo-mechanisms in the "Whispering Giant" are actuated by air from high pressure bottles. Birlec compressed air dryers ensure maximum safety and efficiency by removing harmful moisture vapour to prevent freezing at the release valves as expansion takes place.
Backed by over fifteen years specialised development, Birlec compressed air dryers are currently in use for a wide selection of industrial applications employing pressures ranging from 100 to 6000 p.s.i. Fully automatic and modest in running cost, Birlec drying equipment contributes to the efficient operation of oil refineries, chemical plants and all types of moisture-sensitive pneumatic equipment and instruments throughout the world.

With acknowledgments to B.O.A.C., The Bristol Aeroplane Company Limited and Williams & James (Engineers) Limited.



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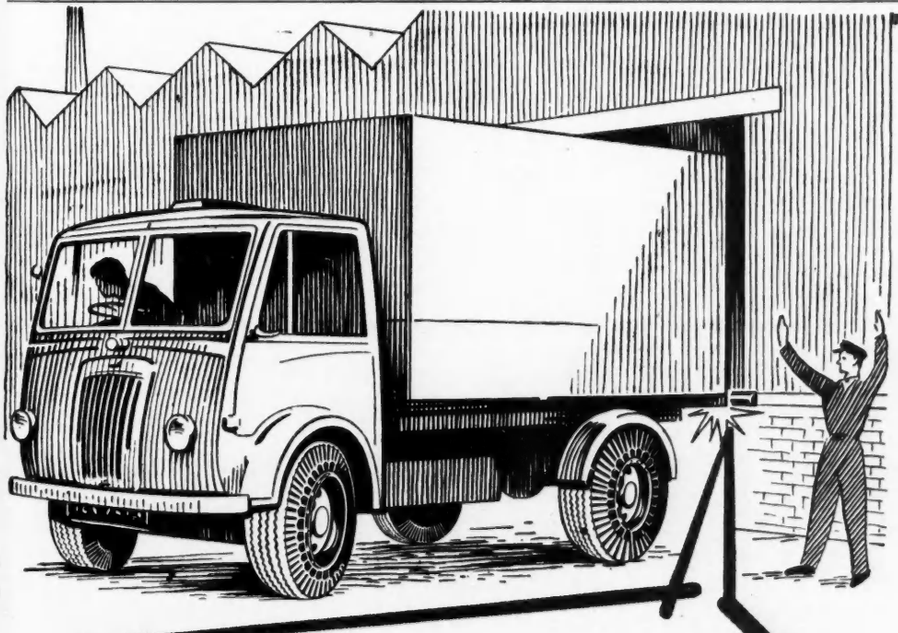

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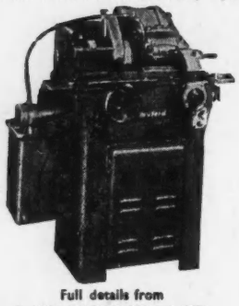

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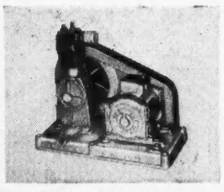

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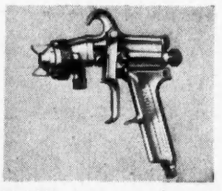

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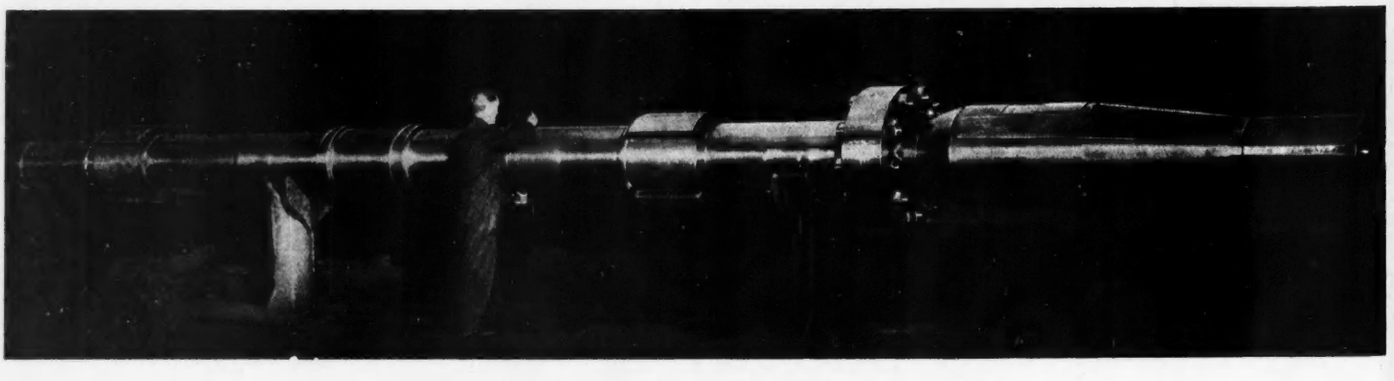

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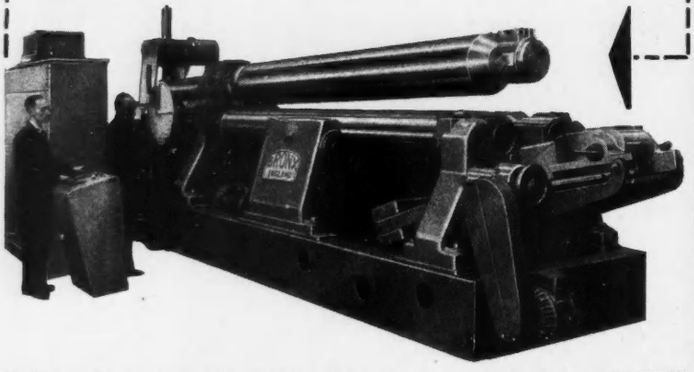

Illustration shows series PBE 810 with swing-down bearing bracket in down position. Photo by courtesy of Consett Iron & Steel Co. Ltd. Durham

● Illustrated is a heavy-duty Bronx three-roll Pyramid Type Plate Bending Roll—complete with a desk type control panel and all the necessary electrical equipment. It is arranged for motor drive and includes an additional top roll which increases the capacity. Vertical rolls are fitted for use in conical rolling. When the machine is fitted with a 16" diameter top roll it is capable of bending mild steel plate 10' wide by 1" thick. With an 18" diameter top roll it can deal with plate 10' wide by 1¼" thick.

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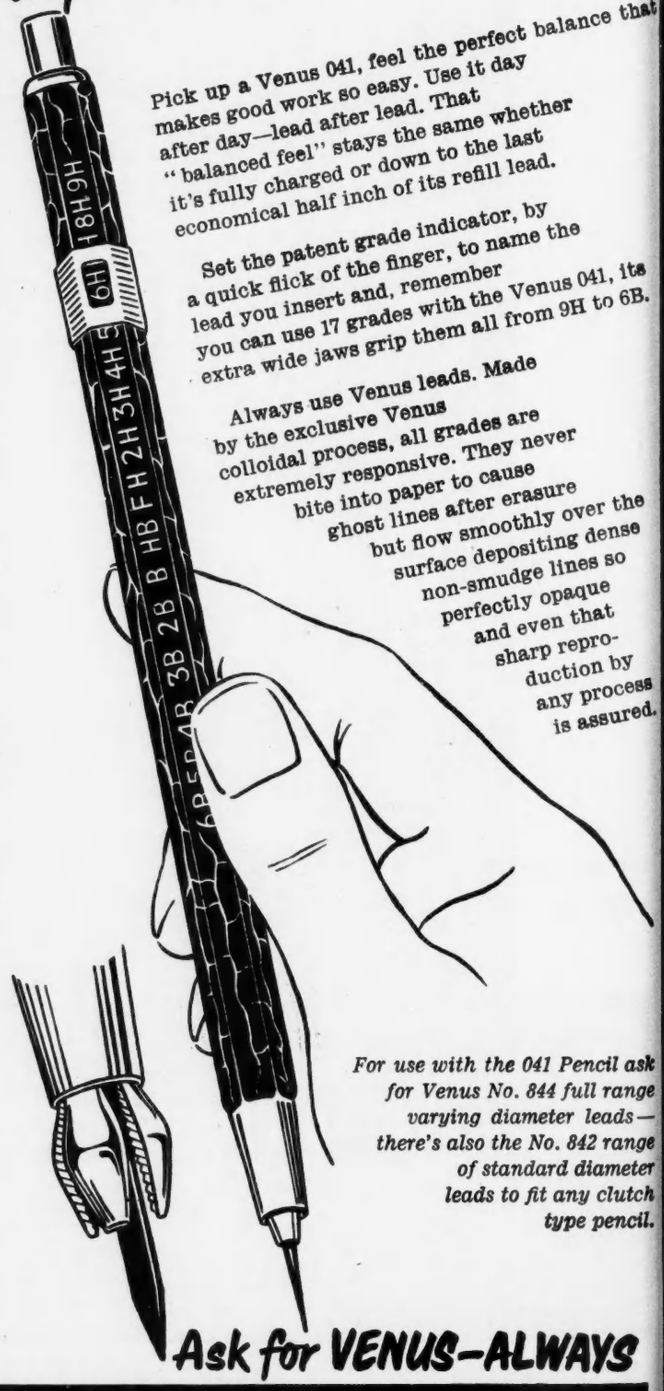

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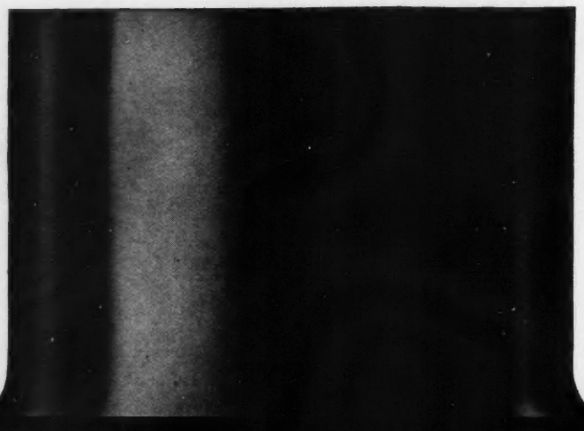

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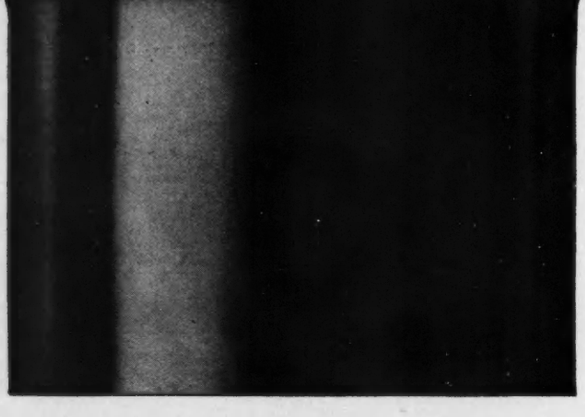

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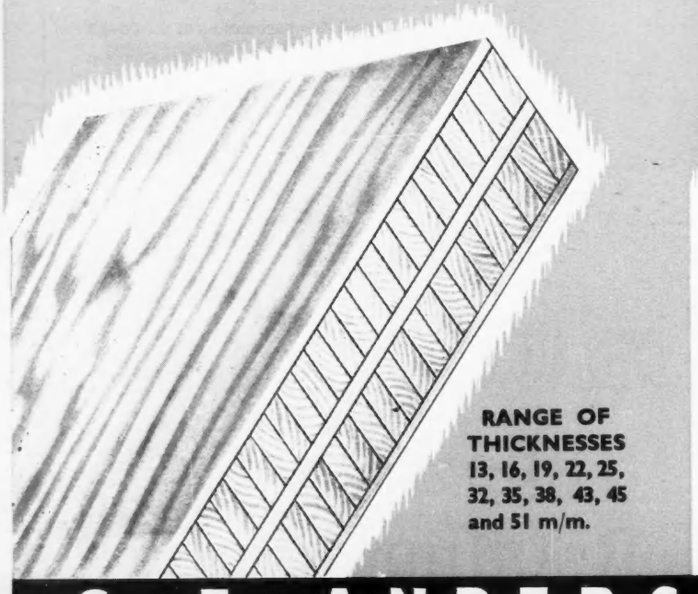

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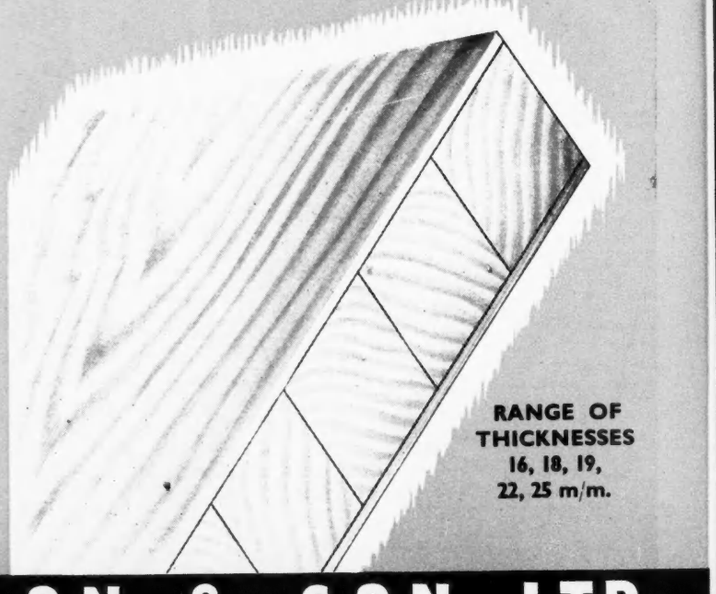

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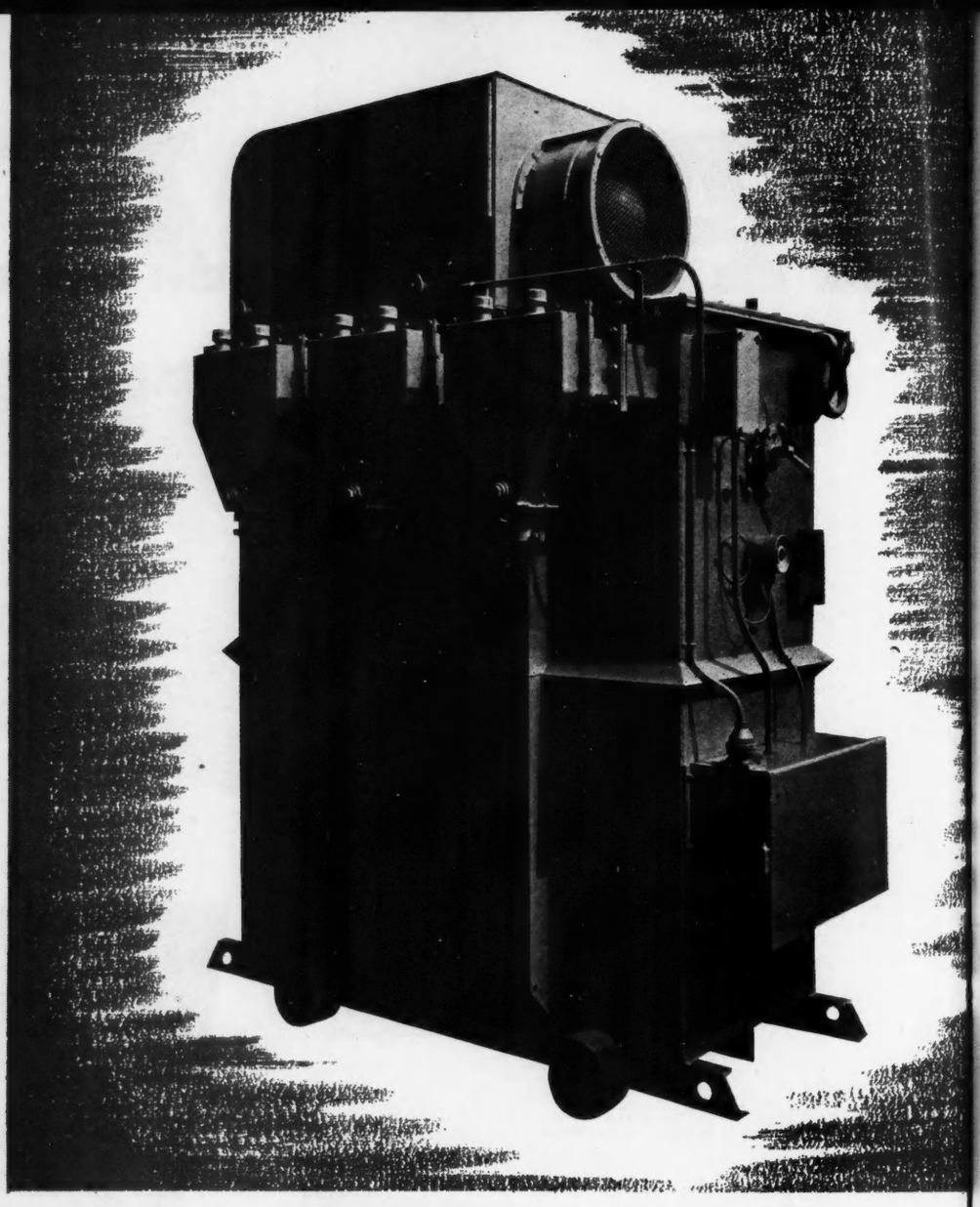

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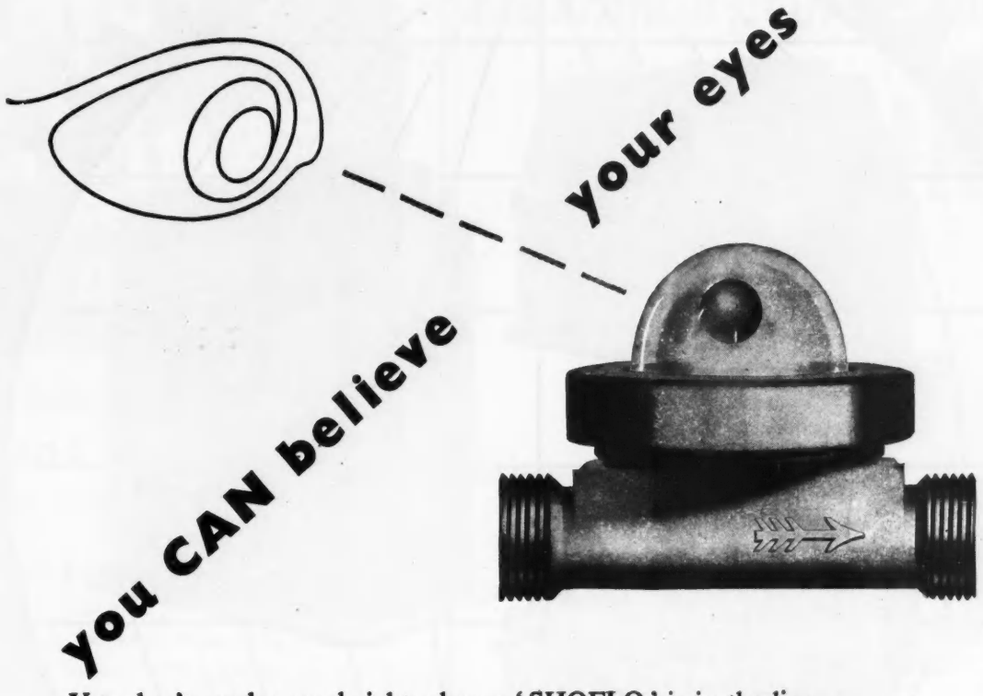

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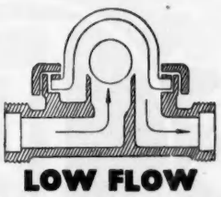

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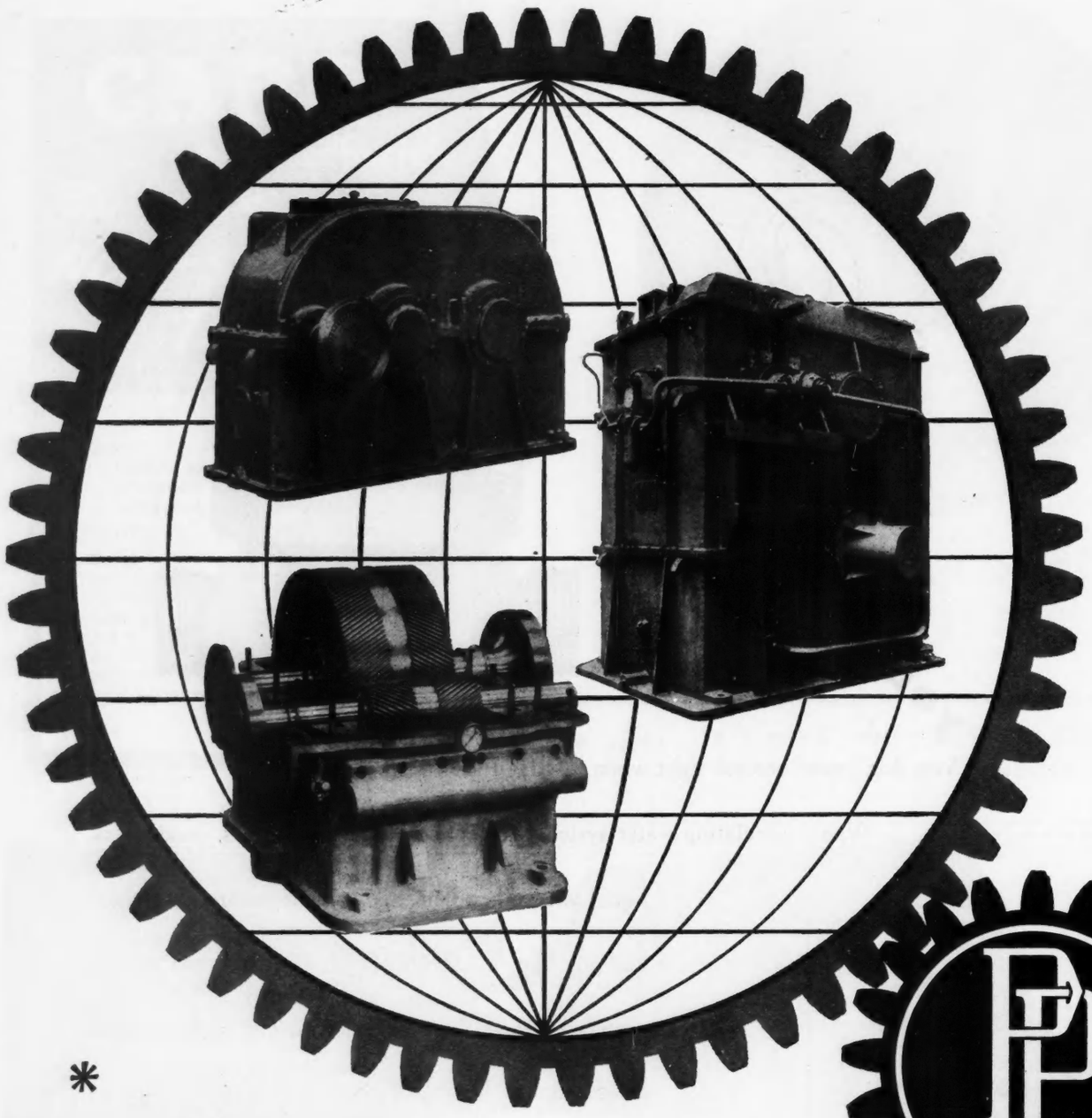

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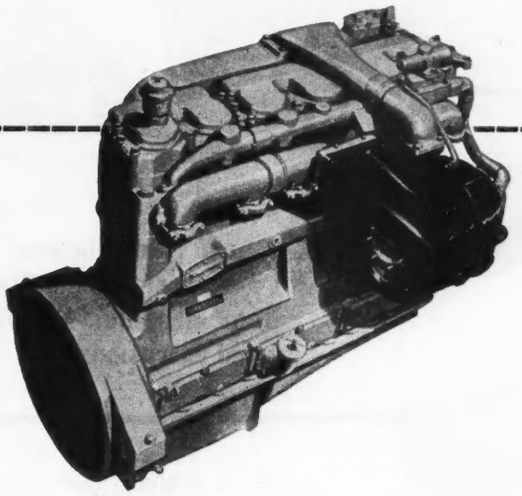

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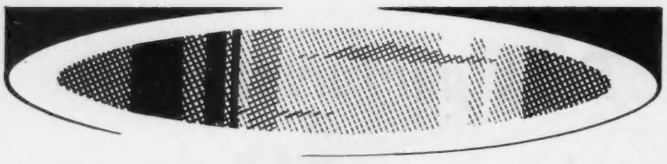

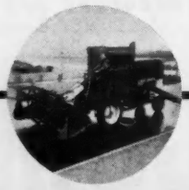

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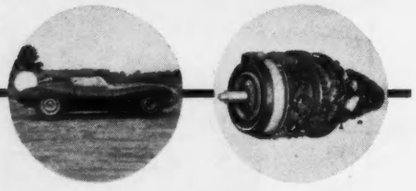

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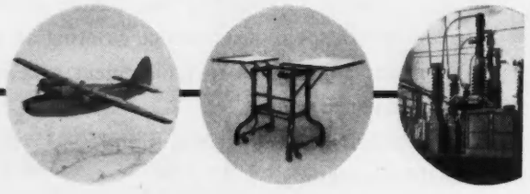

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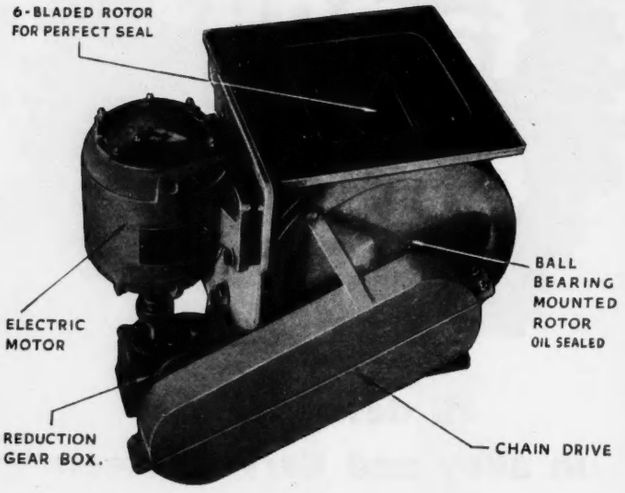

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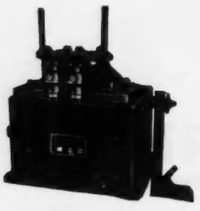

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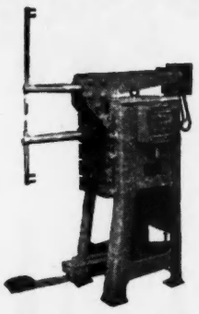

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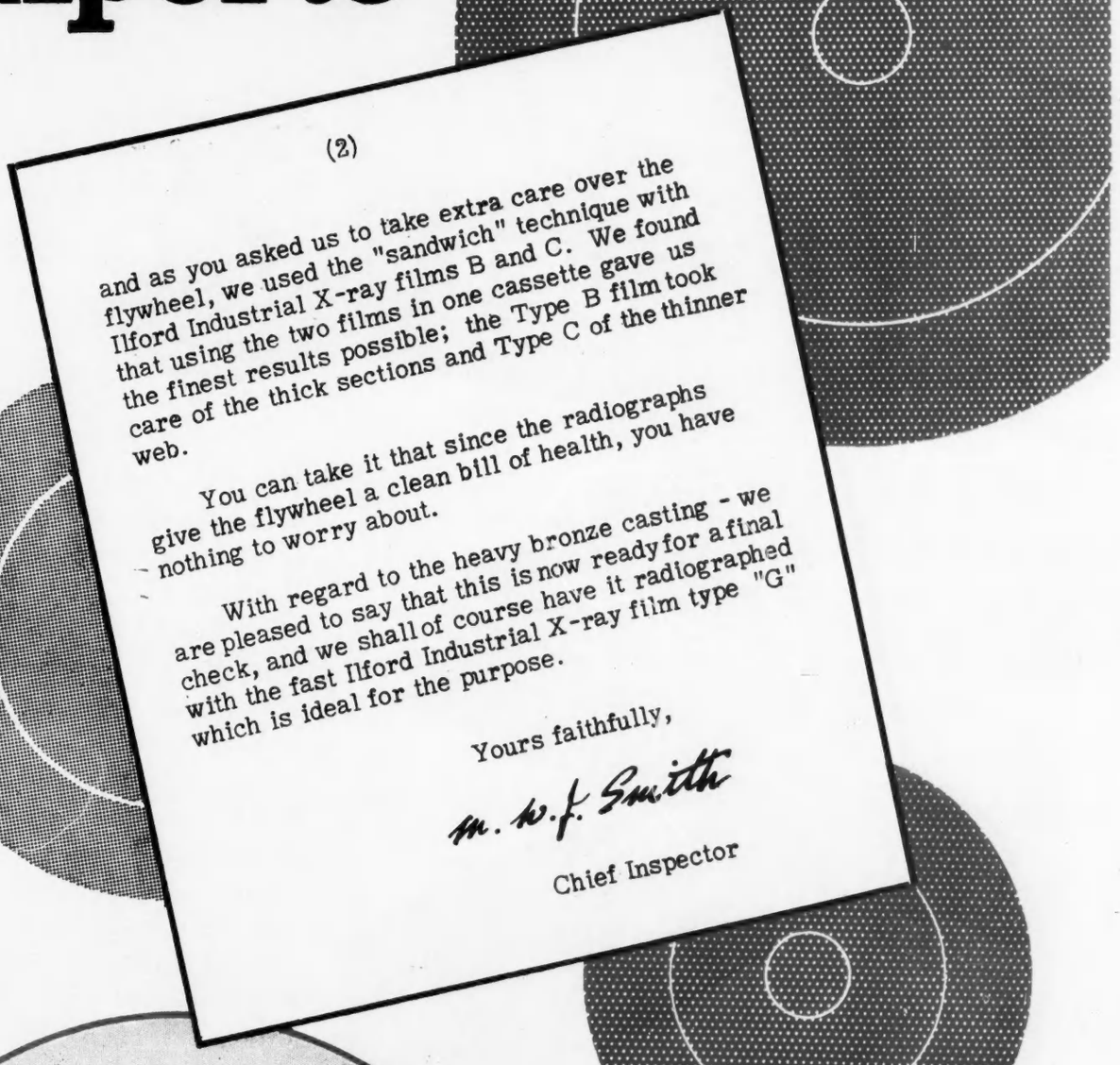
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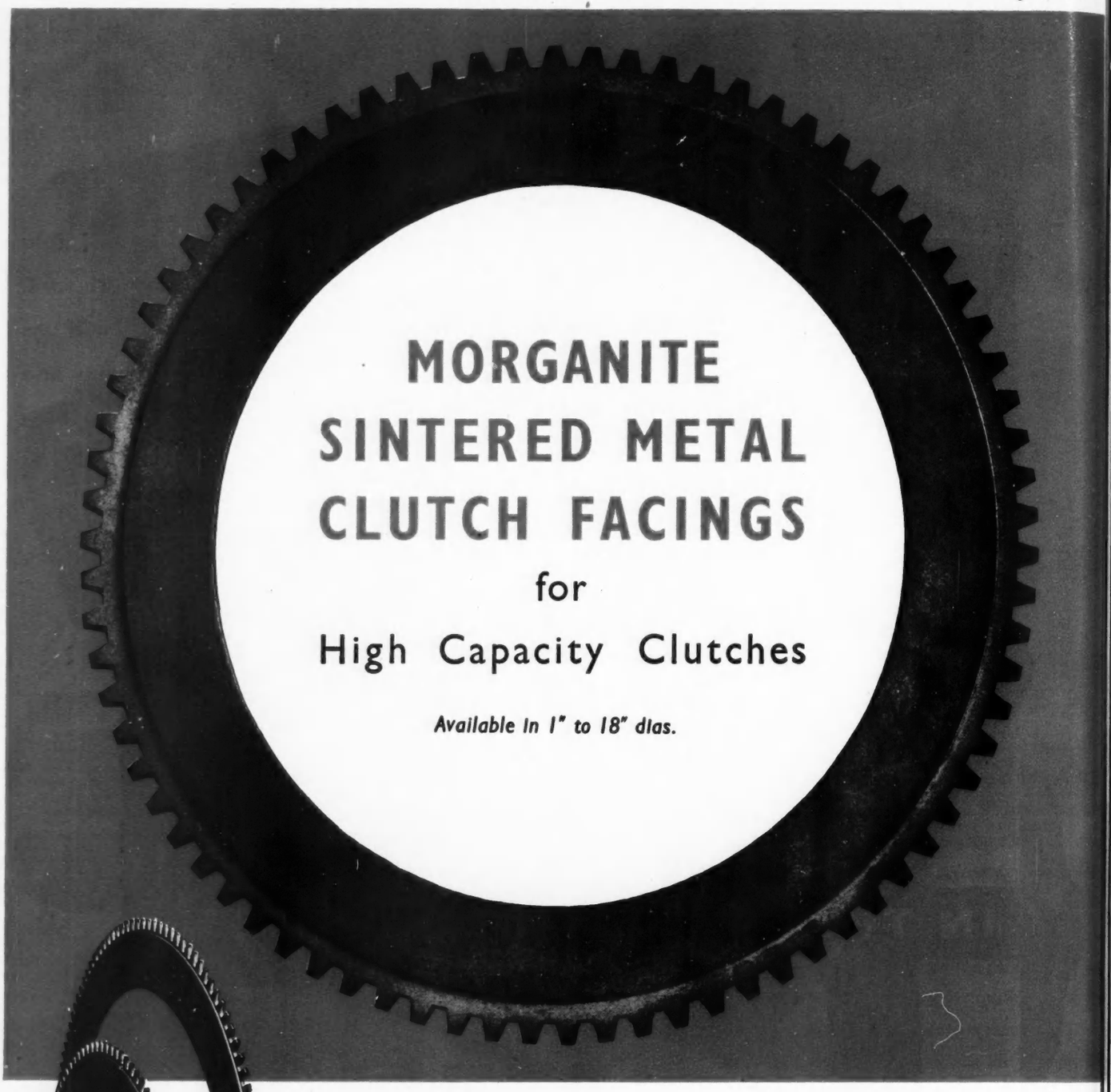

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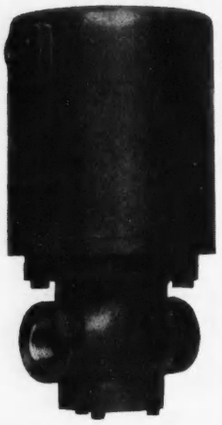

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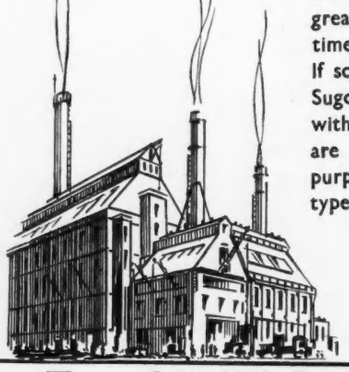

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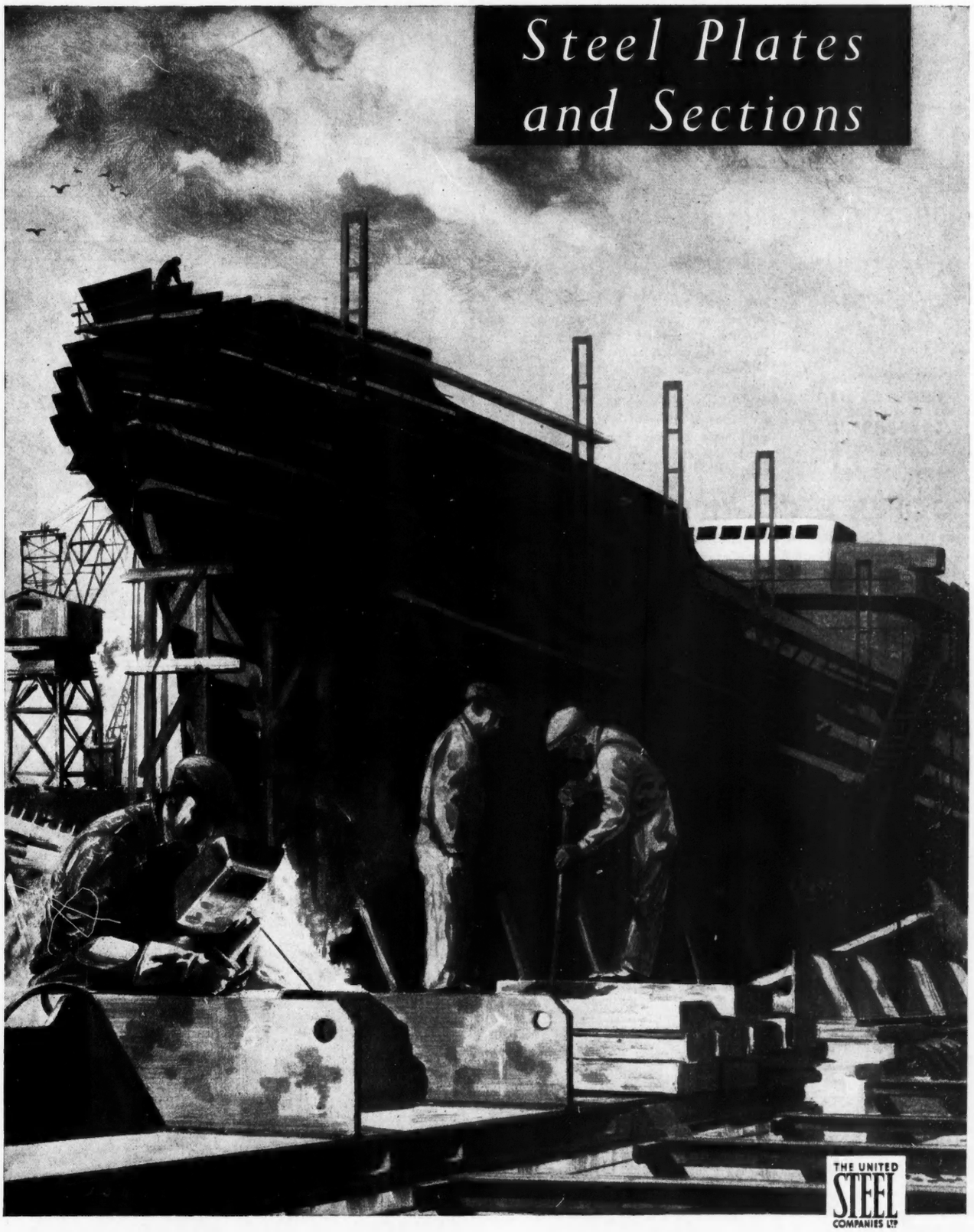

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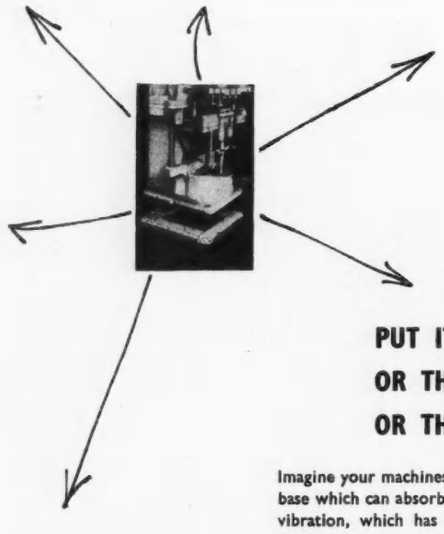

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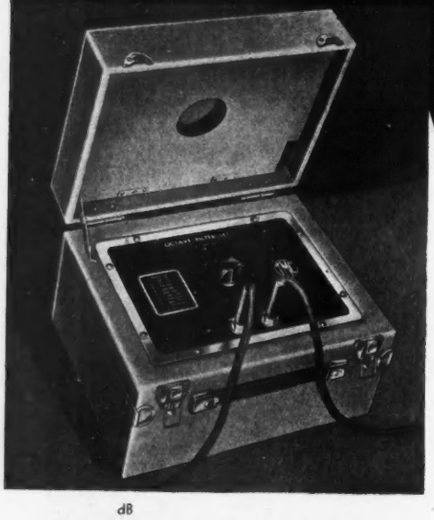

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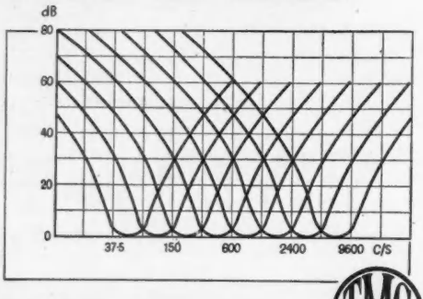

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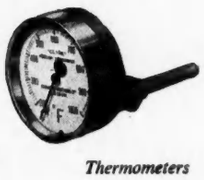

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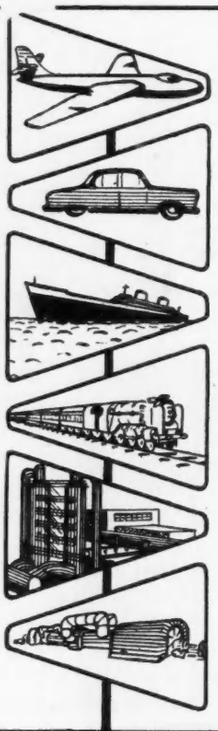

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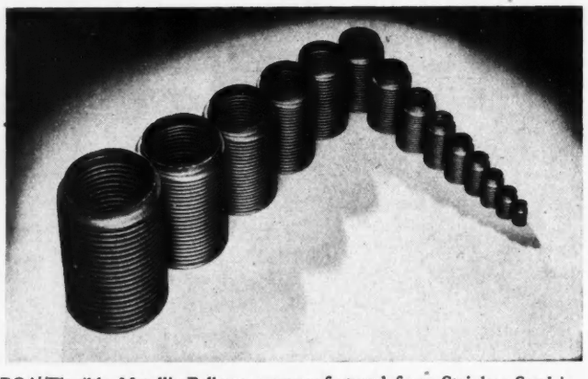

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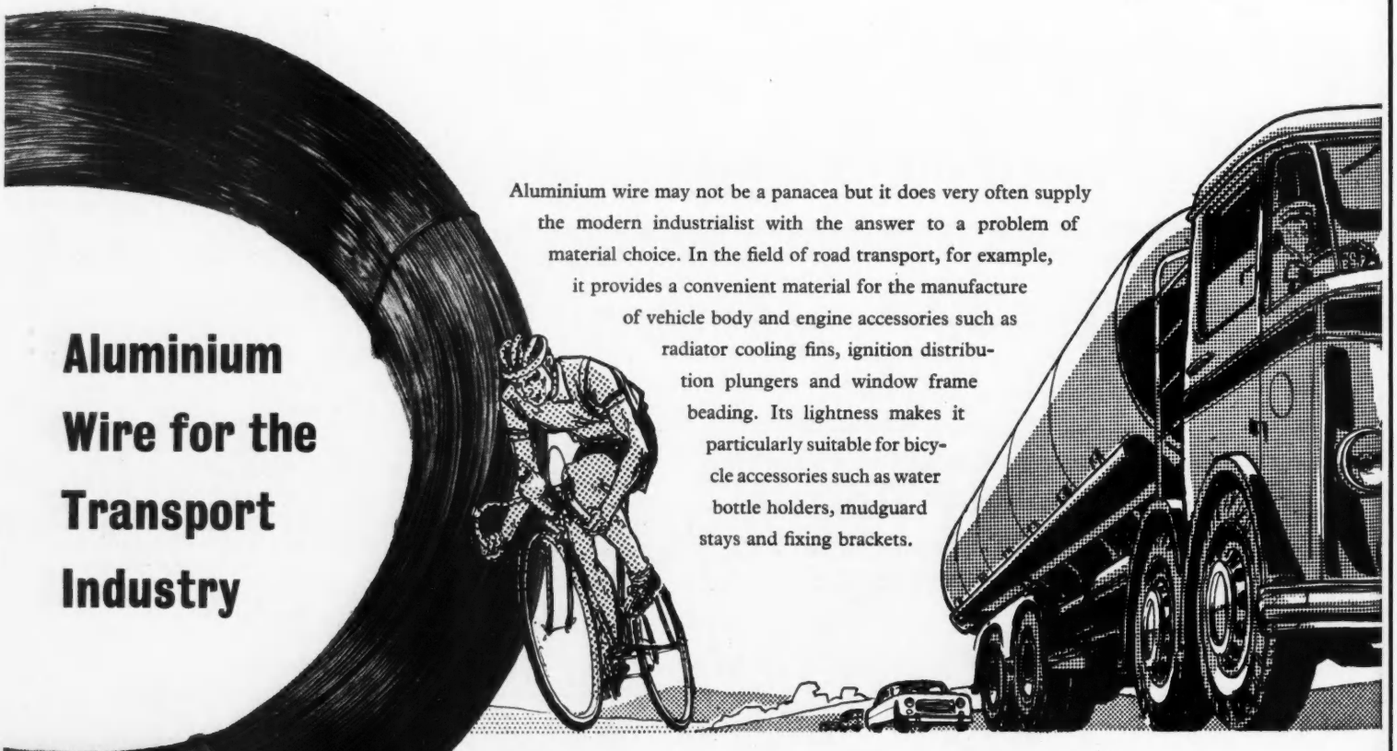

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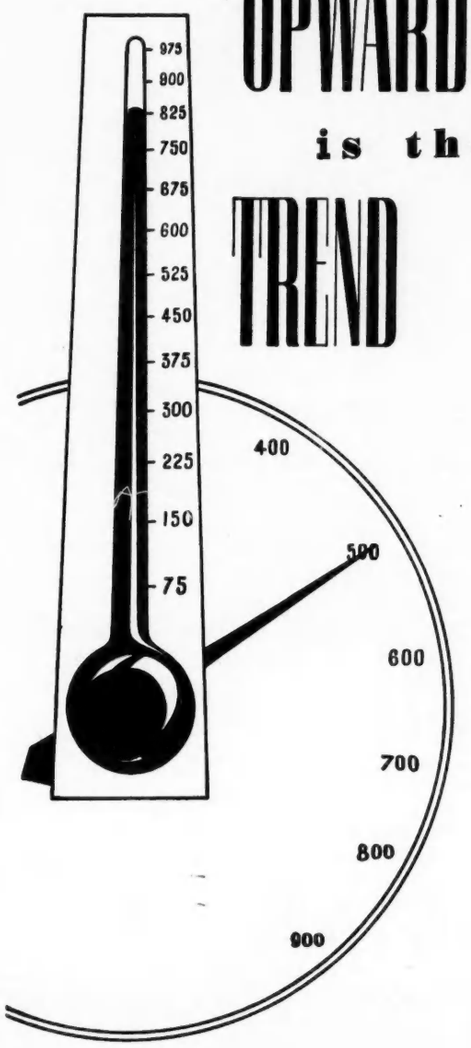

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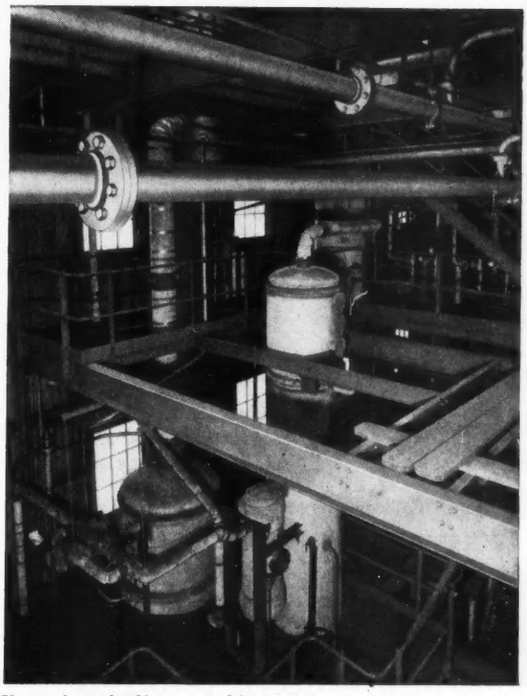

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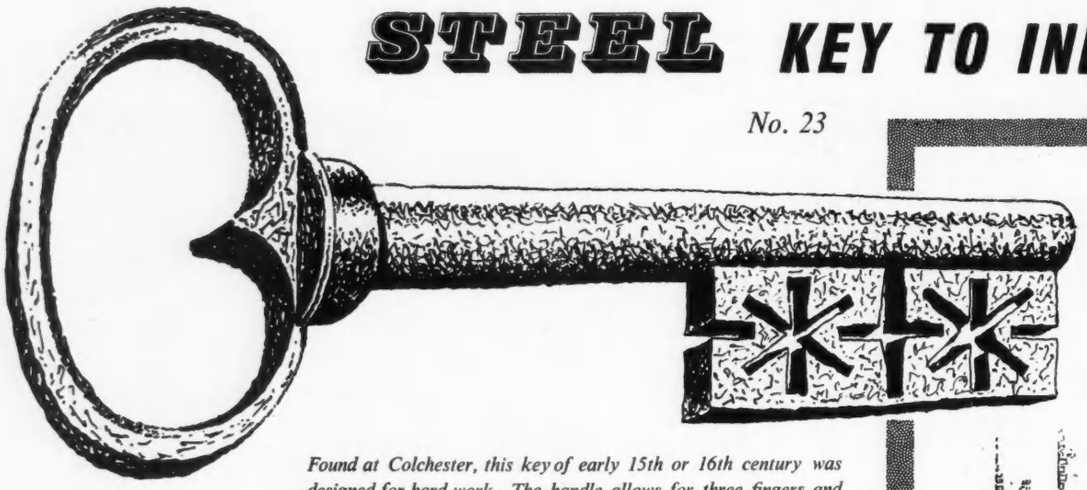

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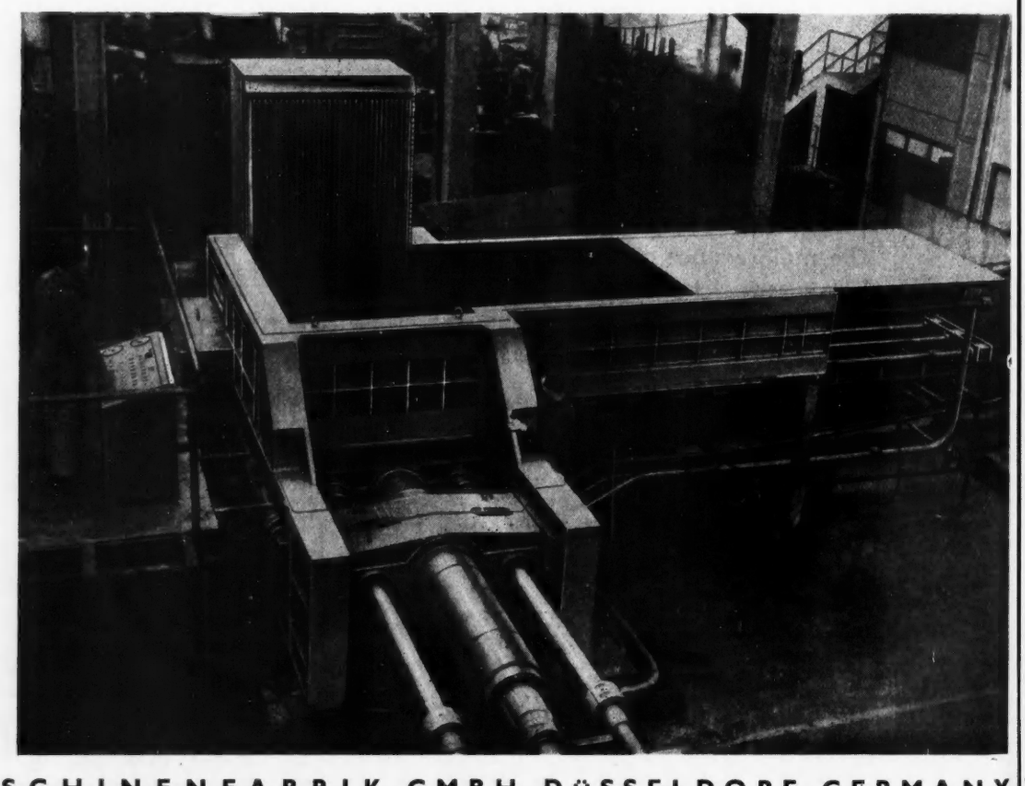

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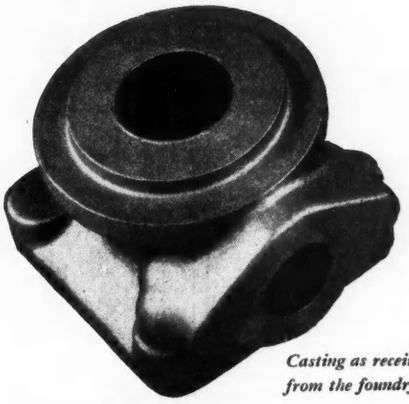

Casting as received from the foundry.

Finished machined casting.

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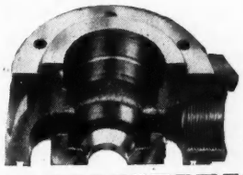

Sectioned casting showing the clean cored passages.

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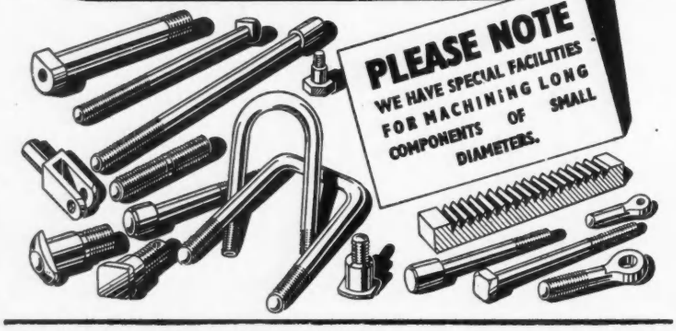

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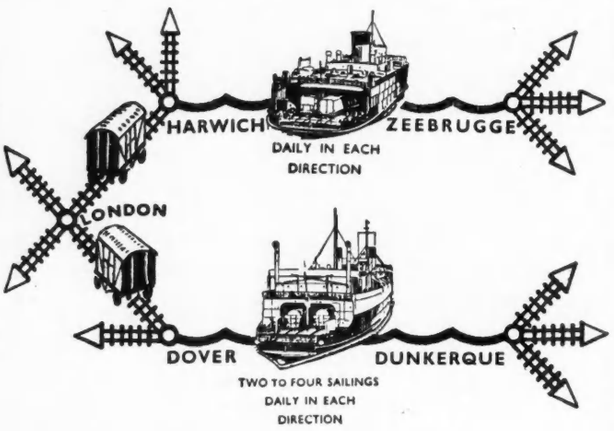

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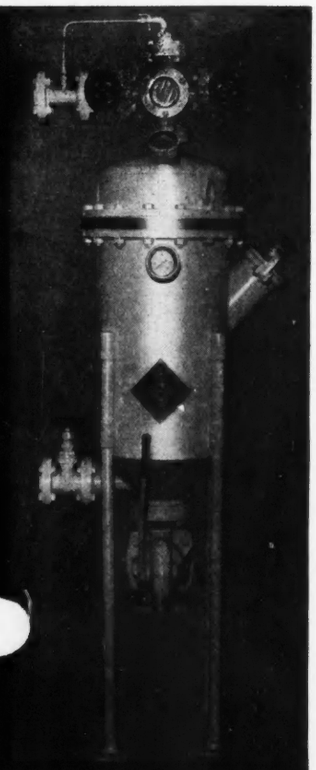

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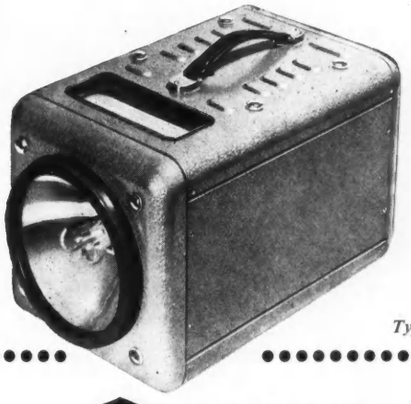

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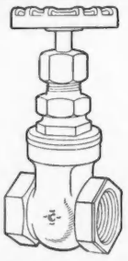

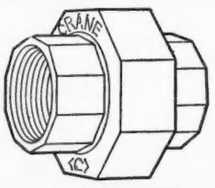

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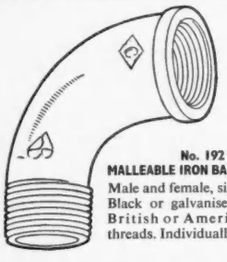

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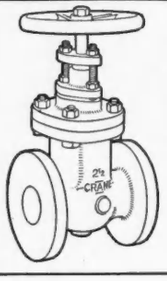

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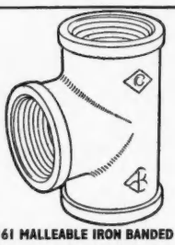

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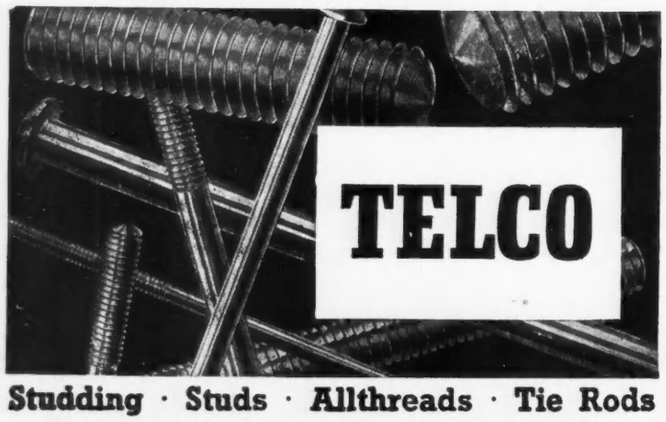

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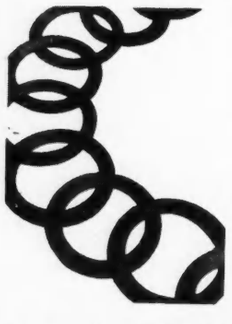

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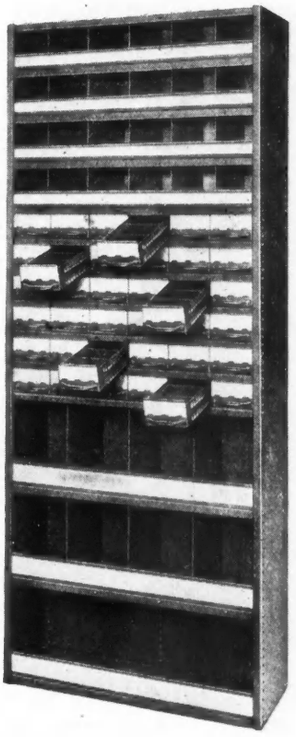

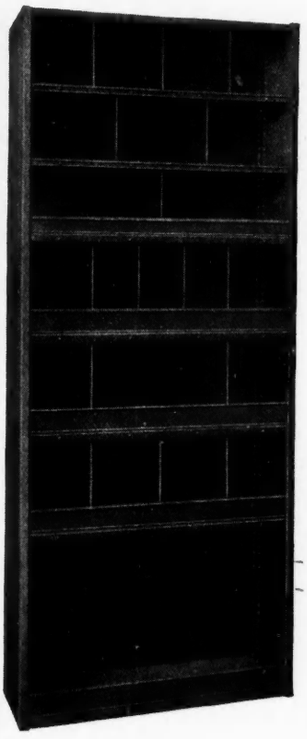

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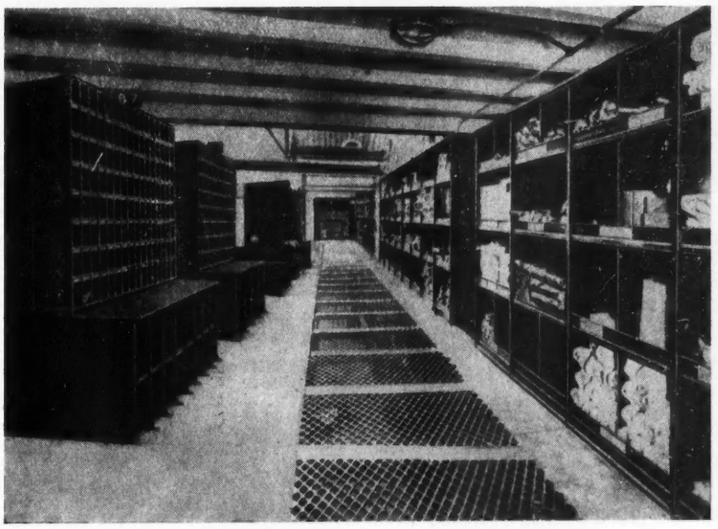

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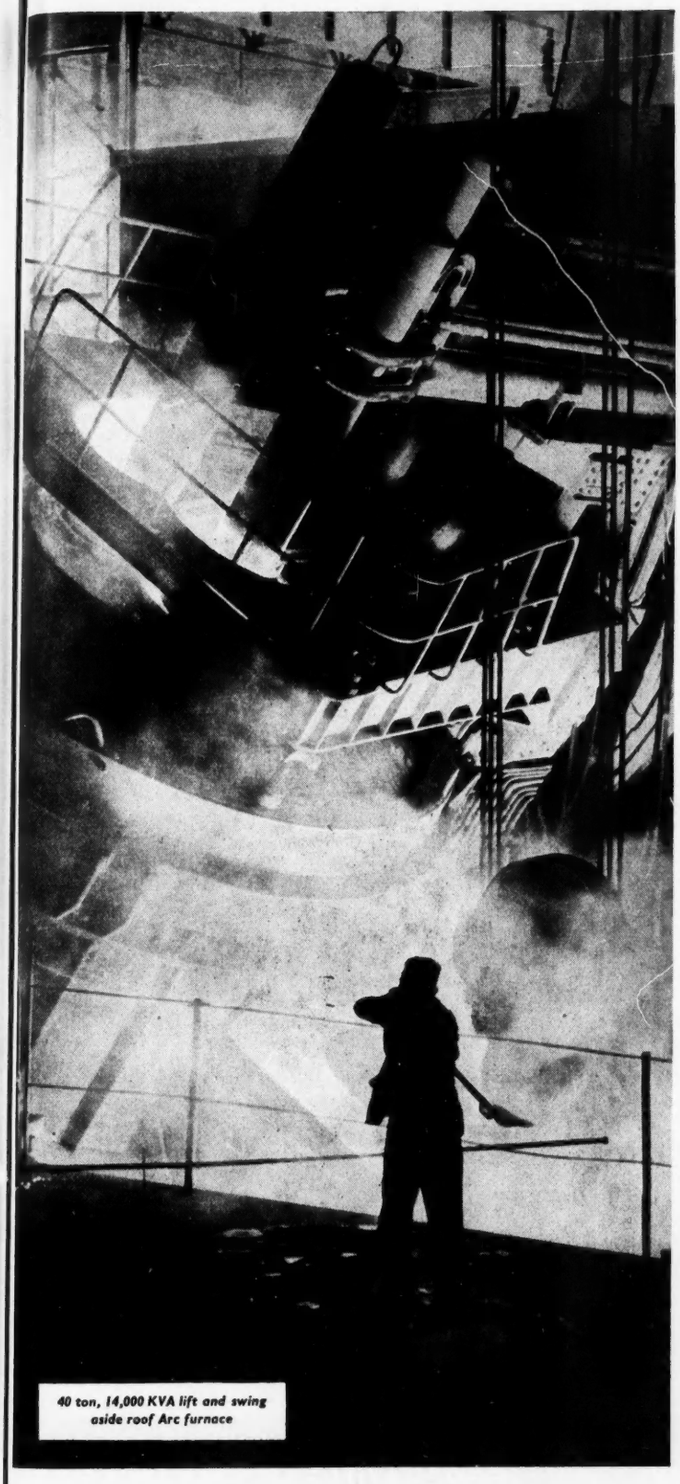

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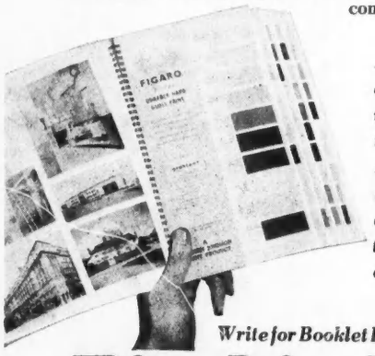

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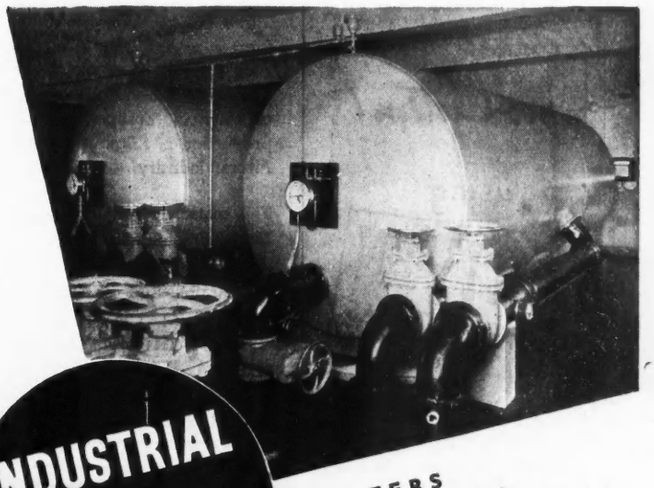

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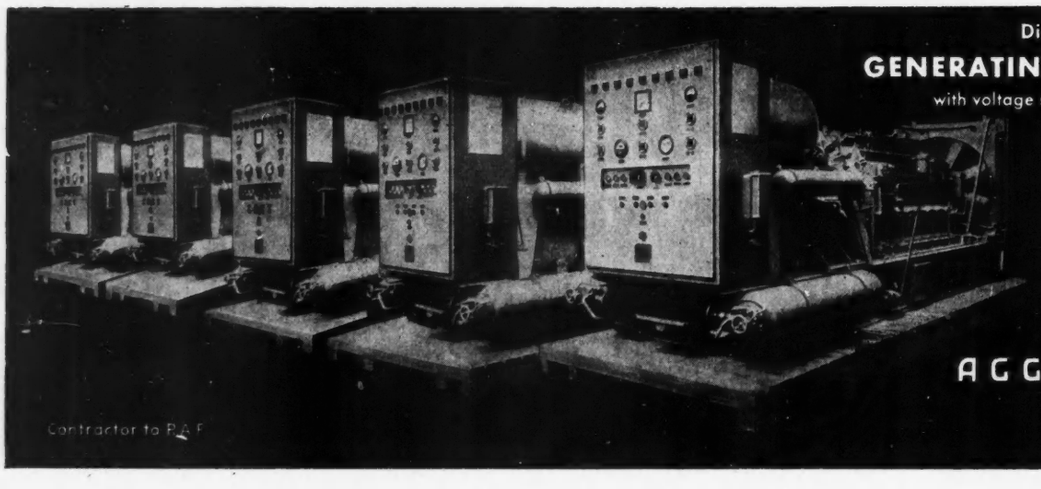

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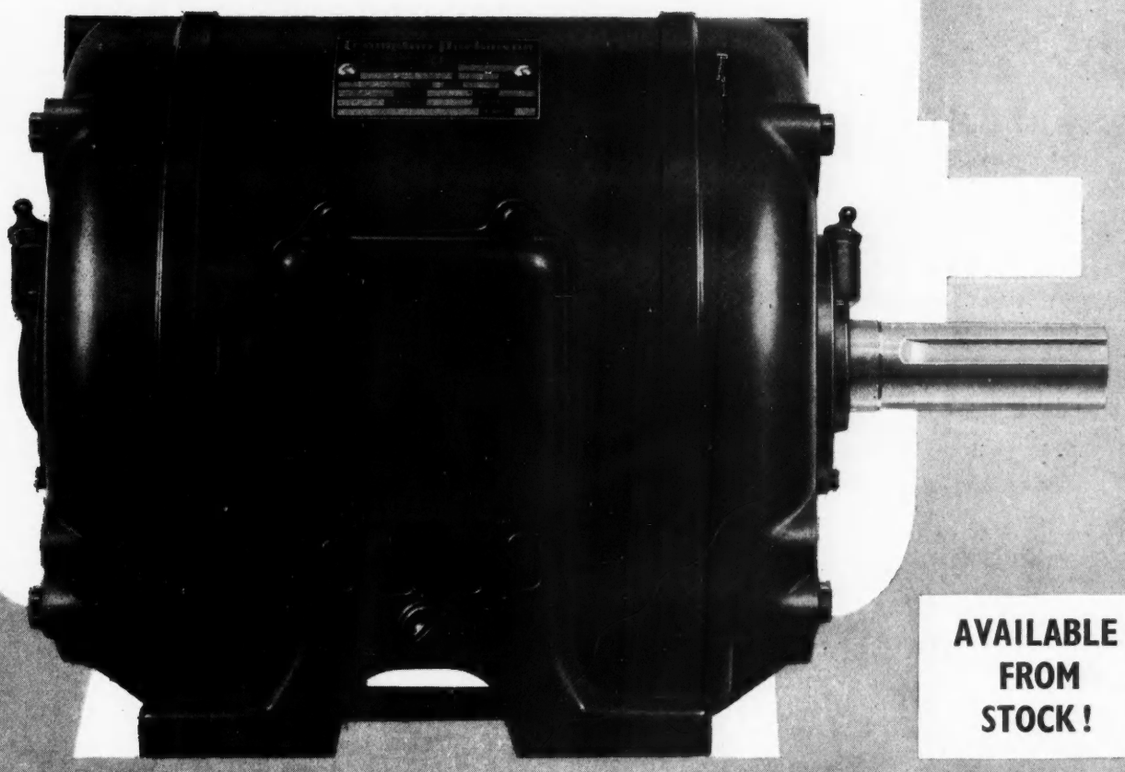
more power in less space

with the new Series 5 motors



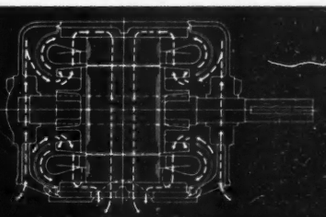
AVAILABLE FROM STOCK!

Crompton Series 5 motors may be as much as 40% lighter and take up only 60% of the space as compared with previous standard motors.

THEY ARE NOW AVAILABLE FROM STOCK IN ALL SIZES UP TO 7½ h.p. AT 1400 r.p.m. and 5 h.p. AT 940 r.p.m.

SERIES 5 MOTORS COST LESS THAN PREVIOUS MOTORS OF THE SAME OUTPUT.

- They comply with a new draft BS for frame size and dimensions and to BS 2613:1957 electrically for Class E insulation.
- They have a protected enclosure with a new, and extremely efficient system of ventilation. The cooling air is discharged centrally between the motor feet at very low velocity. The shields which direct cool air over the bearings provide complete protection for the end-windings.
- Both ends of the motor are identical. One end cover is a spare for all motors of two frame sizes.
- Roller and/or ball bearings are fitted throughout.
- Rotors are squirrel-cage, dynamically balanced and virtually indestructible.
- Stator insulation consists of synthetic enamel covered wire with slot insulation of polyester film on leatheroid; on the end-windings terylene sheet or tape. All joints between coils are *welded* and protected by terylene sleeves.
- Outputs: 1 h.p. to 50 h.p. Speeds: 2, 4, 6 and 8 poles.



Typical Airflow Arrangement. A.C. Squirrel Cage Ventilated Motor Series 5

Crompton Parkinson LIMITED

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BENDIX AVIATION CORPORATION U.S.A.

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...the Bendix range of
A.N. Connectors
including the new sealed
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AIRCRAFT COMPONENTS DIVISION
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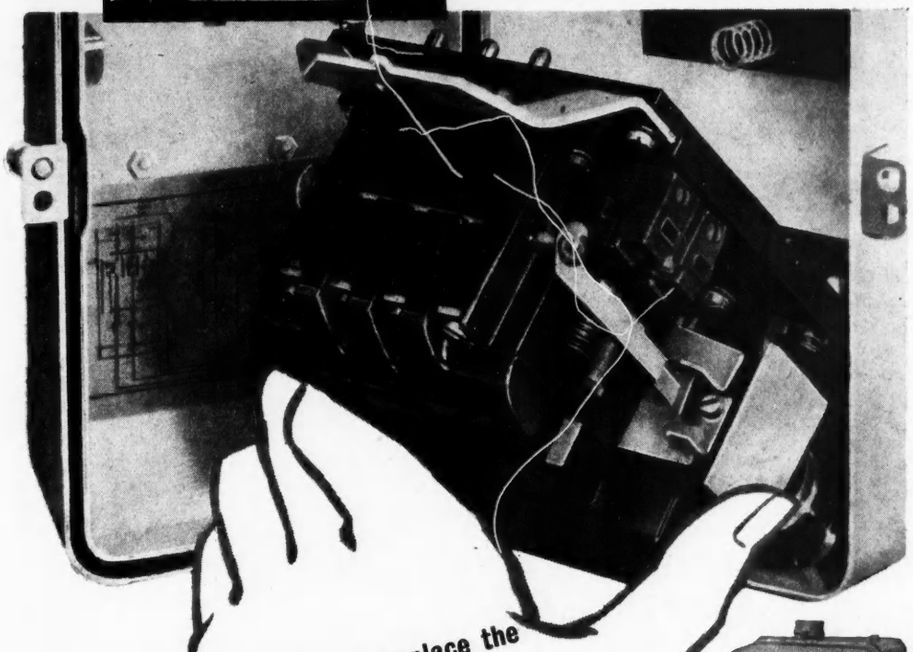
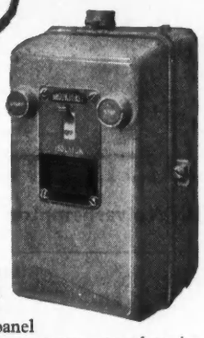
TYPE 616

THE BROOKHIRST PLUG-IN STARTER



To remove or replace the interior unit of the BROOKHIRST 616 STARTER is a matter of seconds . . .



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. . . the front-connected block contactor and overload relay are mounted on a moulded panel having plug-in isolating contacts secured to its underside. Withdrawal entails no more than releasing a retaining clip; no tools required; no trailing cables to disconnect. The 616 starter is ideal for applications demanding continuous running. Suitable for 3-phase squirrel cage motors up to 7½ H.P. 550 V. Full details in Leaflet 1800.

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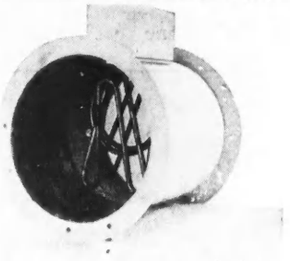

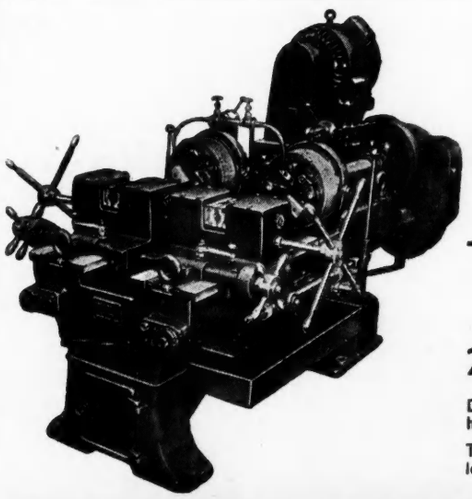

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The machine is fitted with our patent TANGENTIAL Die Heads, which open automatically when any predetermined length has been threaded. Capacity: Bolts up to 2½in. dia., pipes up to 2in. dia., parallel or taper.

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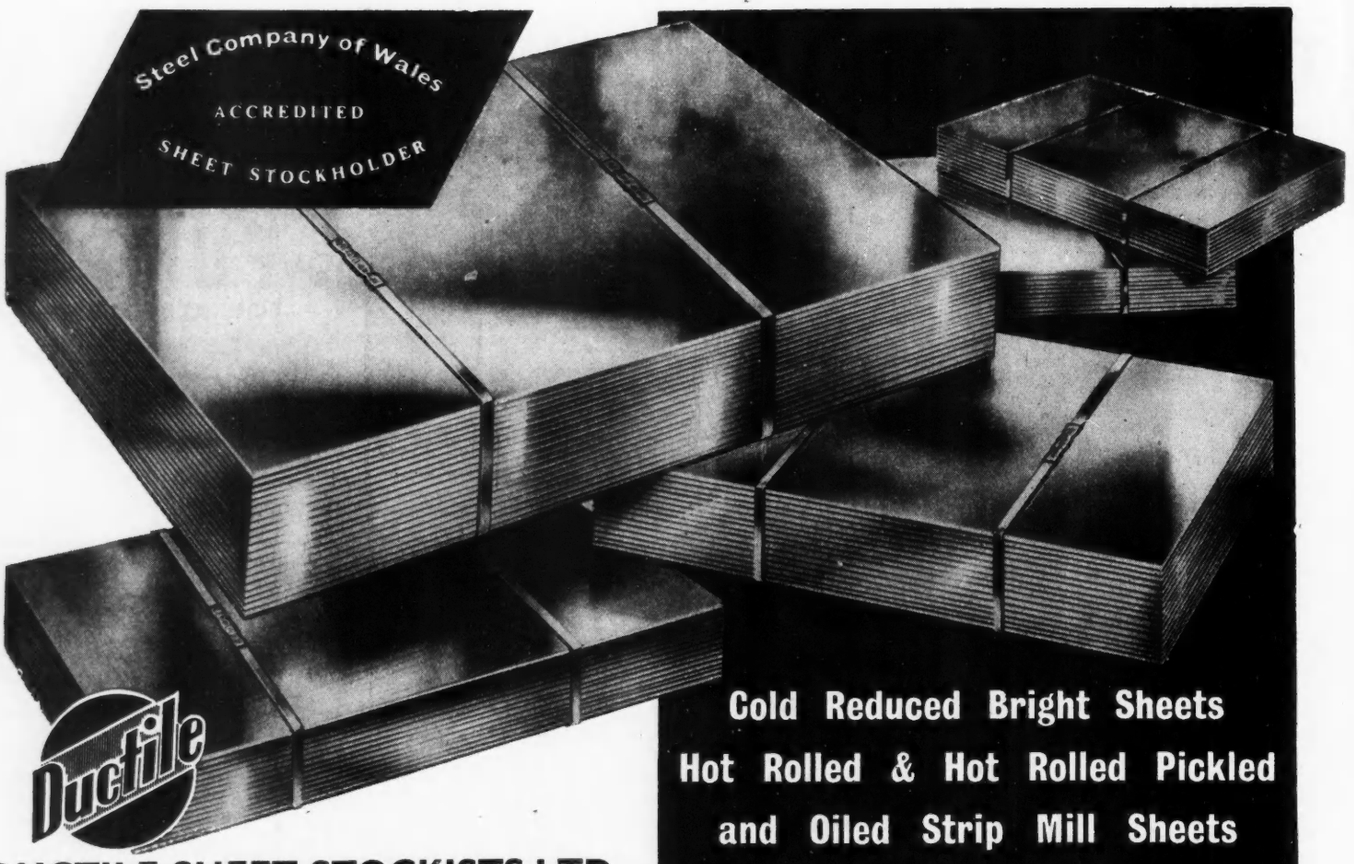

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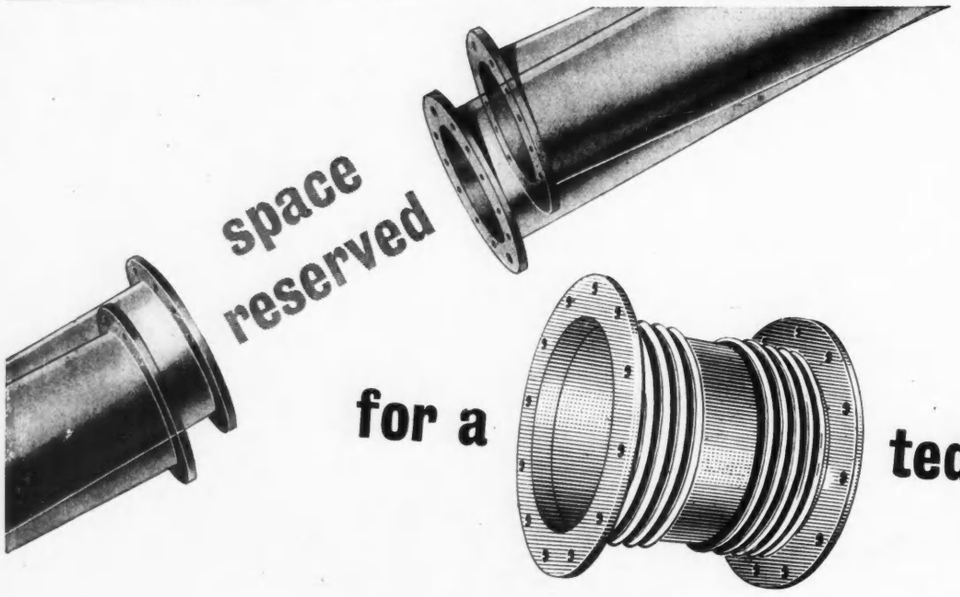

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Movement of pipe work under modern high-pressure and high-temperature conditions is absorbed efficiently by TEDDINGTON BELLOWS EXPANSION JOINTS. Teddington Bellows are of highest quality stainless steel, flawlessly butt-welded to ensure perfect uniformity of wall for maximum durability. Normal production ranges from 1 inch to 7 feet diameters and larger sizes can be made. Your expansion problem can be solved by our experienced engineers who are always available for consultation and recommendation

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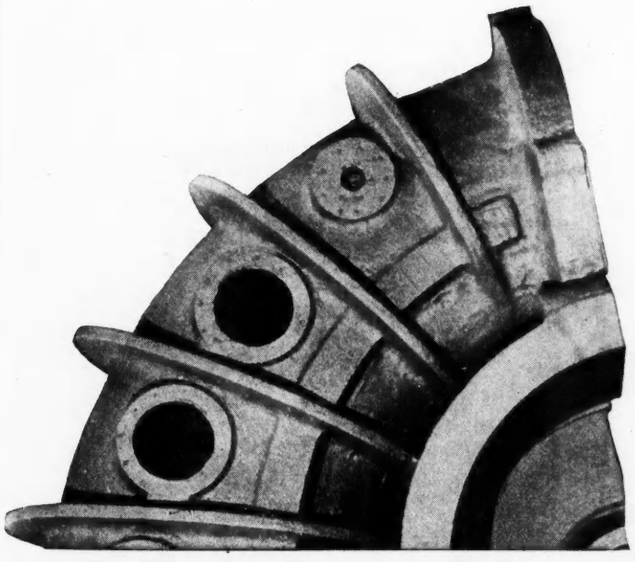
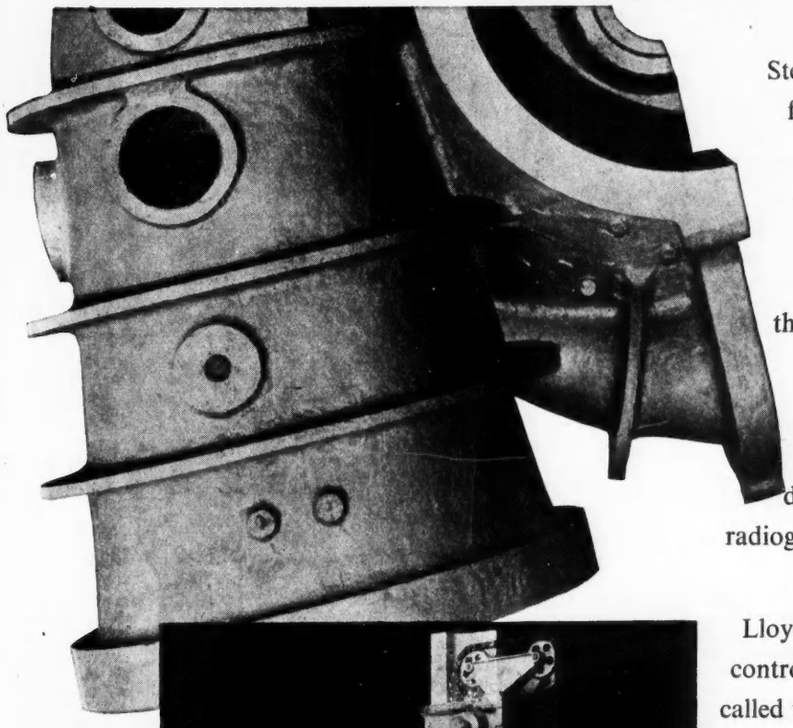
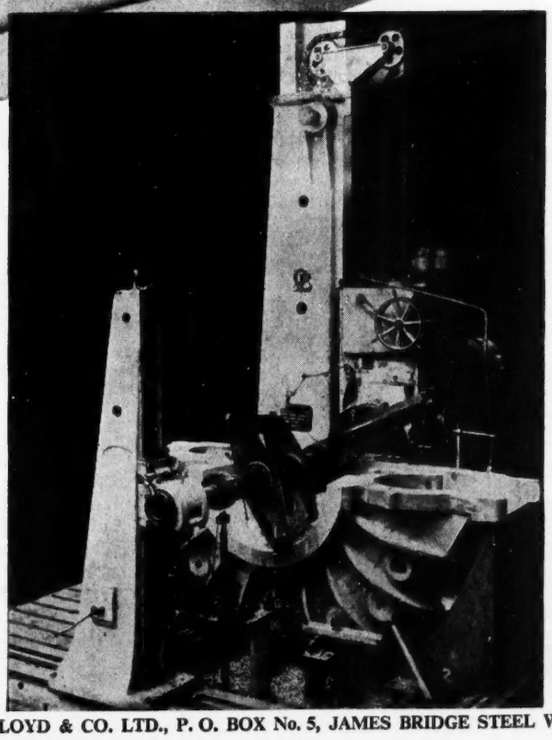


Half gas circulator casing cast in steel and machined for C. A. Parsons & Co. Ltd. for Nuclear Power Station, Calder Hall. Weight as cast 35 tons. Sectional thickness max 7" min 1½". Reproduced by permission of C. A. Parsons & Co. Ltd.

cast and machined for an important part





Steel castings are performing a number of important functions in the production of Nuclear Power, not least being the gas circulator casings cast for C. A. Parsons & Co. Ltd. reactors.

They form an integral part of the atomic pile, circulating as they do the carbon dioxide coolant through the reactor. Their dimensional accuracy and tolerances must be of a far higher standard than is usual in normal engineering practice.

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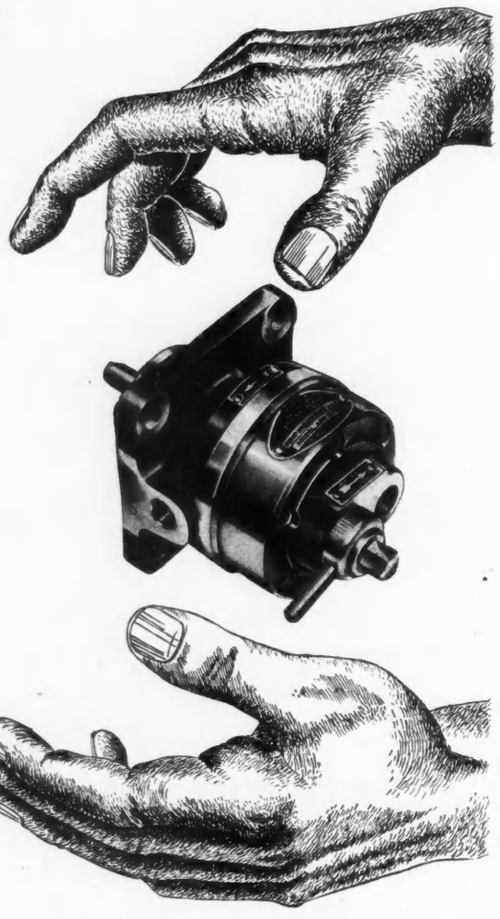

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Paradoxically, the product of human skill is more accurate than human skill itself. This is particularly so in the case of Savery Hydraulic Pumps. Countless thousands of Savery Pumps are in use throughout the world working with precision that neither human skill nor other means can match. Next time you're considering control of motion remember Savery Hydraulic Pumps first. Savery Pumps can be supplied with fixed or variable delivery.

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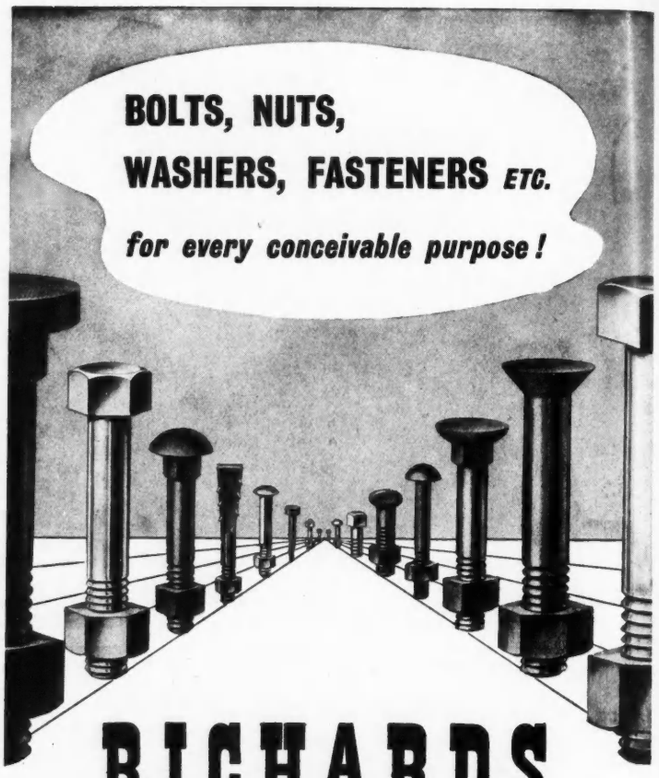

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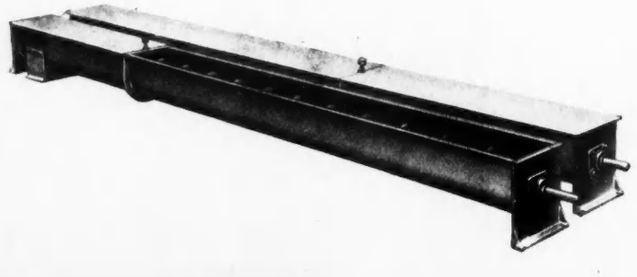
Made in standard sizes from 4in. diameter up to 20in. diameter in any lengths up to 150ft. Either screw flights and shafts only for mounting in clients' boxes or complete screw conveyors to our standard. Send for leaflet No. 110 giving full particulars of our standard screw conveyors and full dimensions for planning to your layout. Clip-on covers ensure dust free operation with easy access for inspection.



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A complete range of Screw Conveyors. Standardised to facilitate installation and subsequent adaptation to plant requirements.

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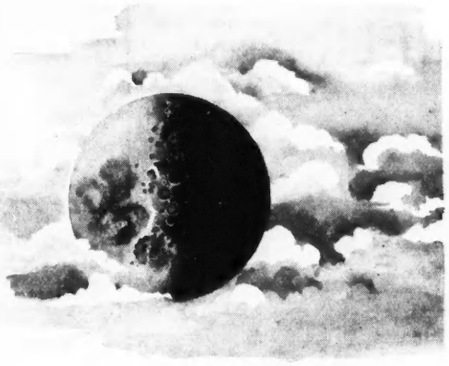
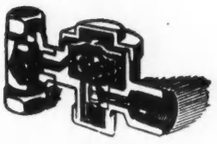
"the moon is made of green cheese"

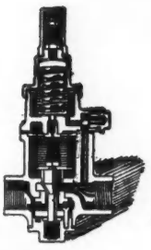


Surely a heading for a fairy tale! Of course it is! It appears here to emphasise that far too many fables are used in advertising instead of facts—personal views of the advertiser and statements in the superlative are made to look like universally acknowledged truths. That's what makes advertising suspect in the minds of so many.

MIL Steam Fittings have so much to recommend them that the manufacturers have no need to over-state or exaggerate. Because of this, every word in their advertising is to be believed—the care and precision at each stage in the making of their products is confirmed by thousands and thousands of satisfied customers and upheld by a two-year guarantee.



MIL STREAM TRAP



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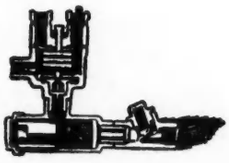
MIL LOW PRESSURE STEAM TRAP

Our Technical Representatives are at your service, meantime may we send full details?



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MIL STEAM FITTINGS

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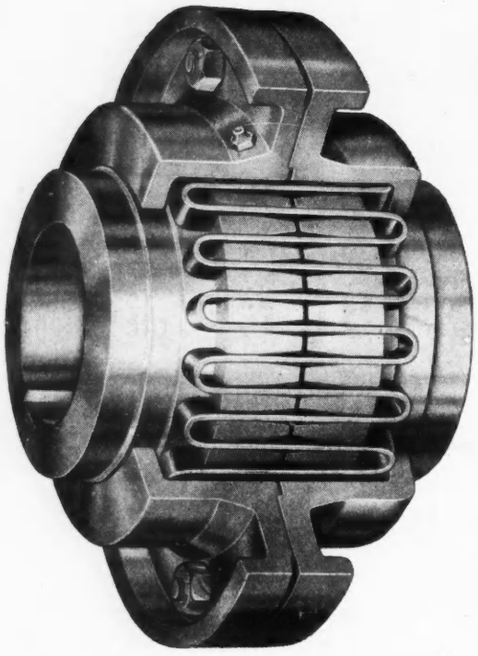

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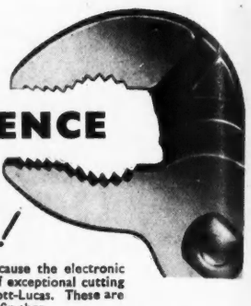

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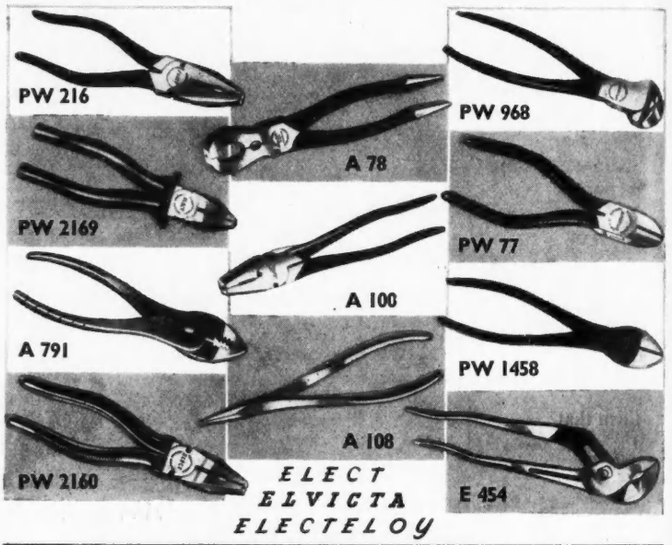

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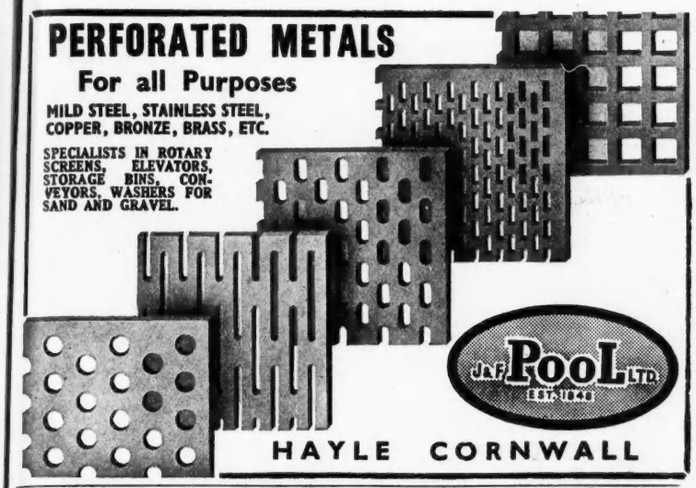

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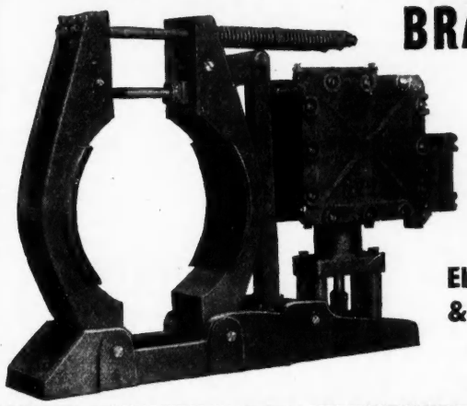

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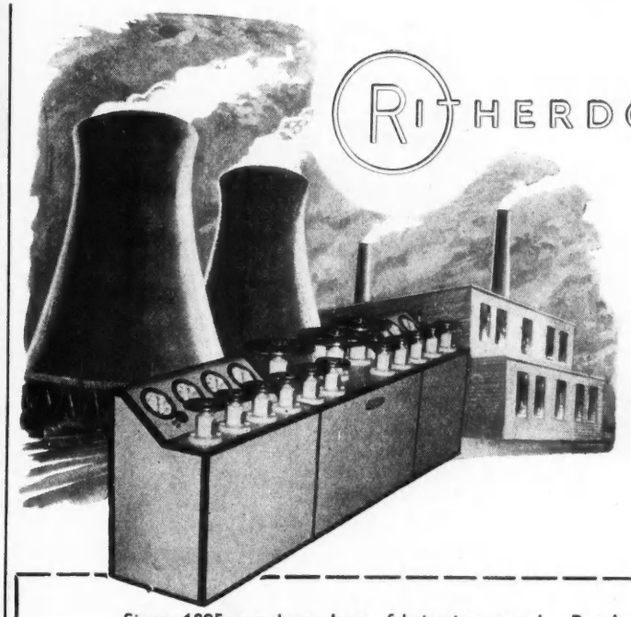

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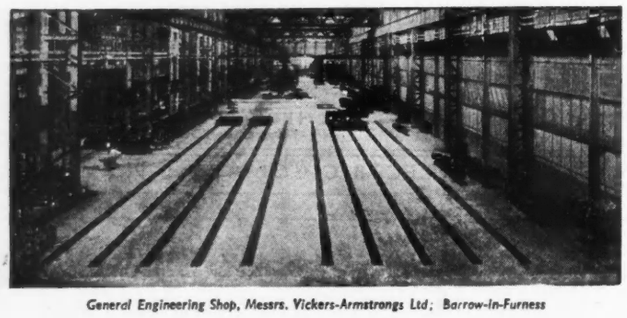

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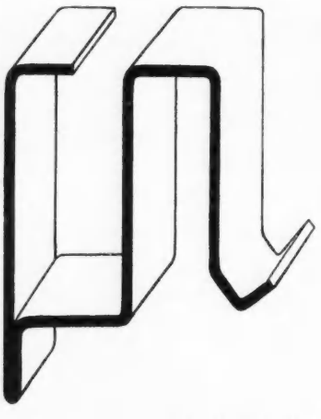

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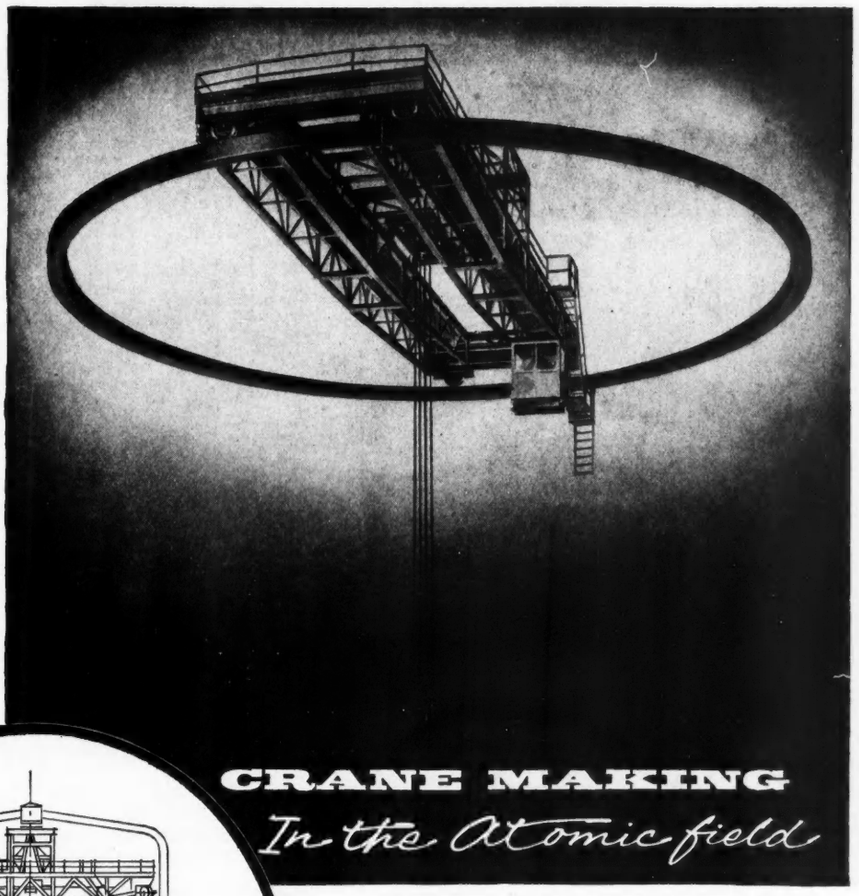

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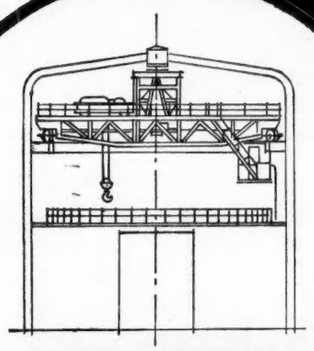

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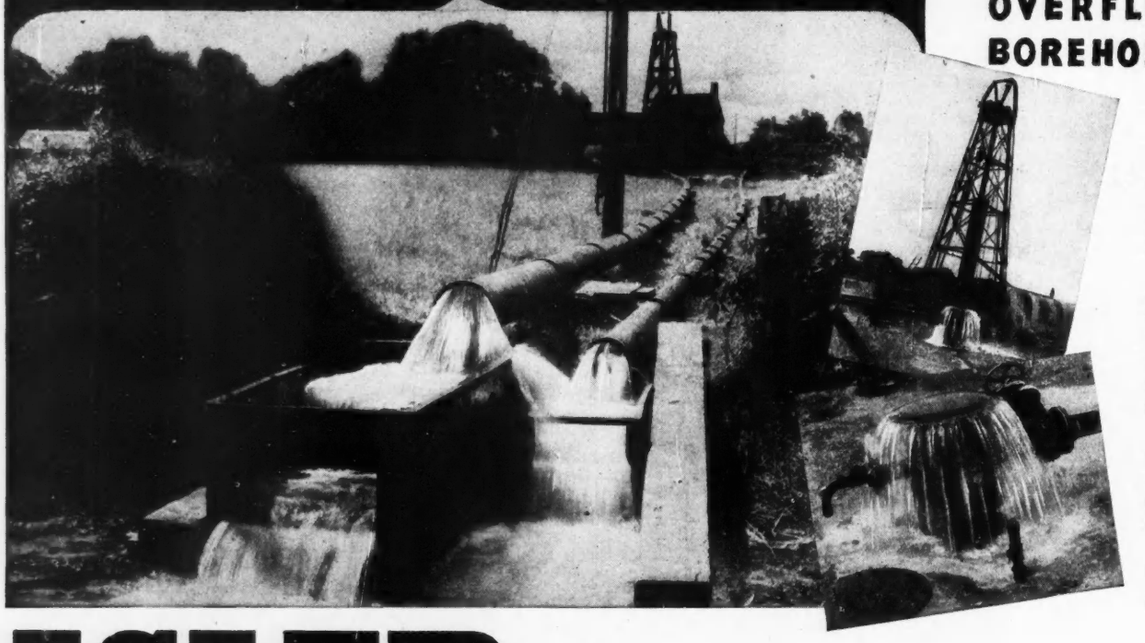

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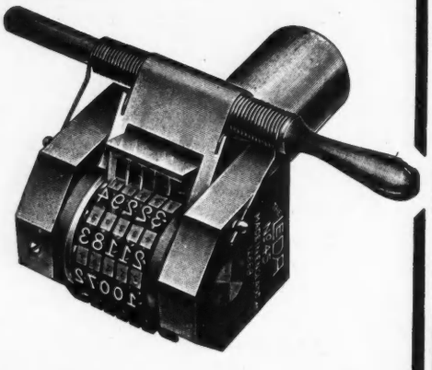

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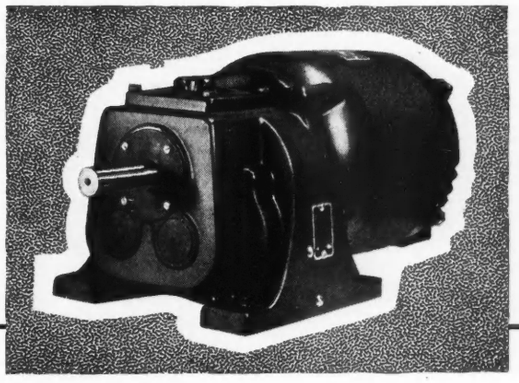

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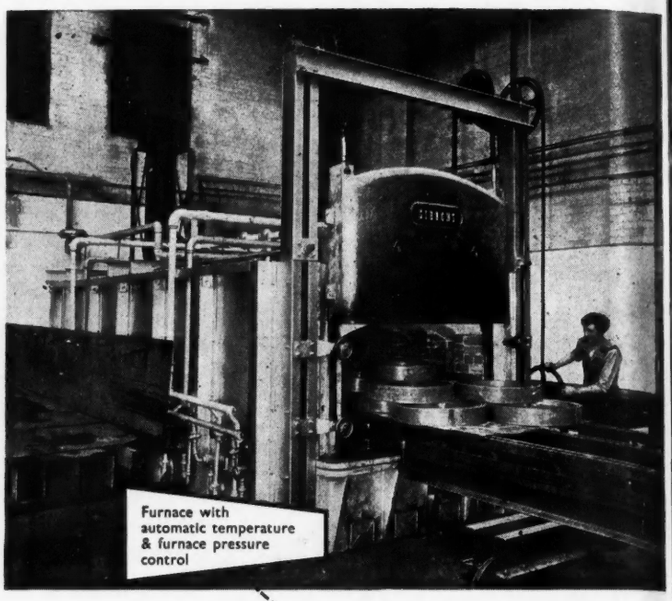

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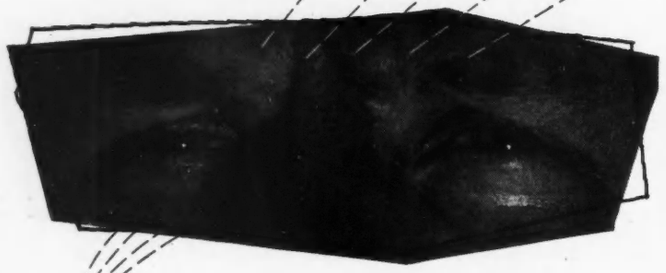

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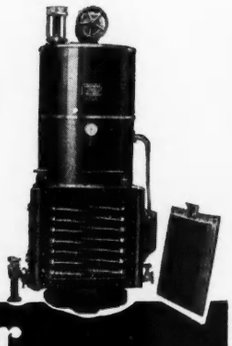

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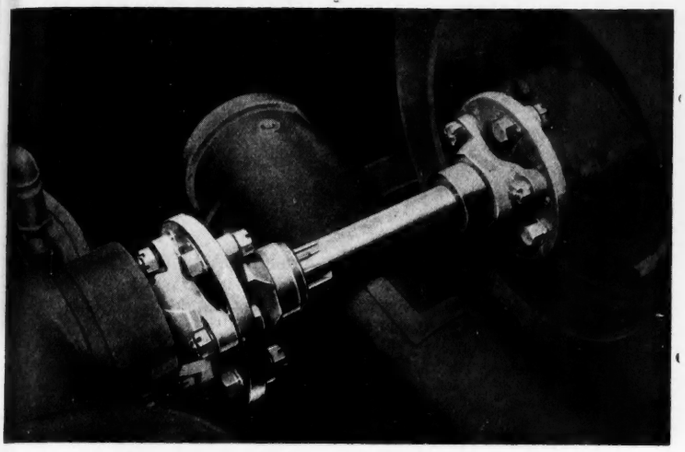

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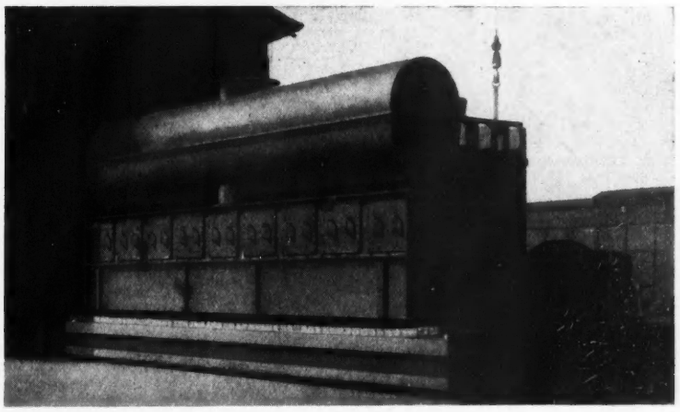

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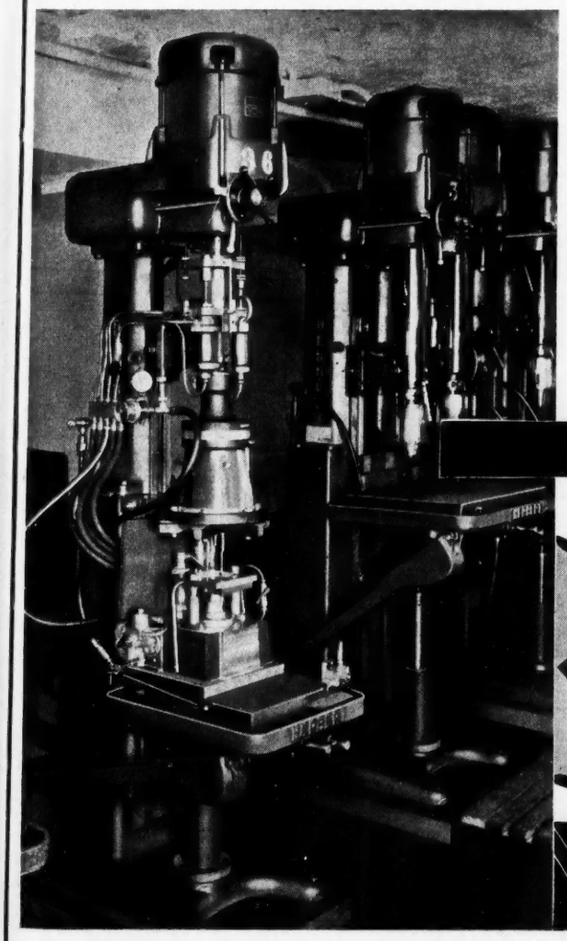

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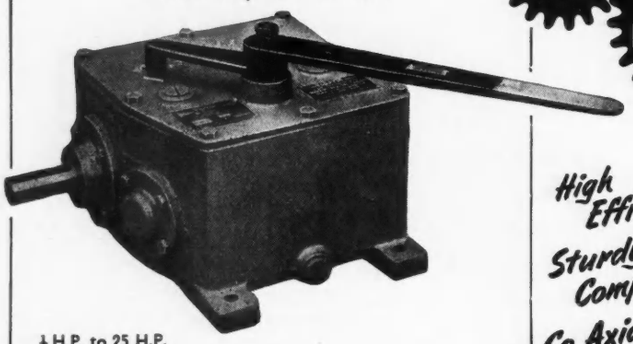

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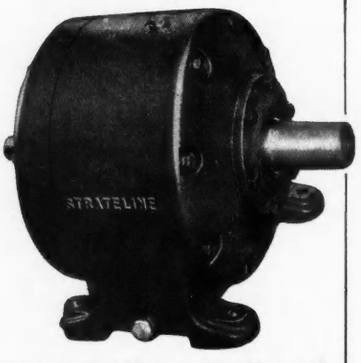

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Description			Carbon Steel Castings for General Engineering Purposes		
Grade			A	B	C
Chemical Composition	Carbon % maximum		0.25	0.35	0.45
	Silicon % „		0.60	0.60	0.60
	Manganese % „		1.00	1.00	1.00
	Nickel % „		—	—	—
	Chromium % „		—	—	—
	Molybdenum % „		—	—	—
	Sulphur % „		0.06	0.06	0.06
	Phosphorus % „		0.06	0.06	0.06
Mechanical Properties	U.T.S. tons/□" not less than		28	32	35
	Yield Stress or 0.5% Proof Stress „ „		14	16	17.5
	Elongation % „ „		22	20	15
	Red'n Area % „ „		—	—	—
	Izod ft. lbs. „ „		—	—	—
	Angle of Bend „ „		120°	90°	—
	Brinell No.		—	—	—
Equivalent Specifications	American Society for Testing Materials	A27-52T	U.60-30	N.2 & 70-36	—
		A148-50T	—	—	80-40
		A217-49T	—	—	—
		Others	—	—	—
	Society of Automotive Engineers		—	0030	0050
	B.S.1504 : 1950		101-A	101-B	101-C
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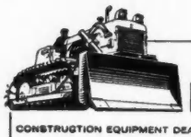

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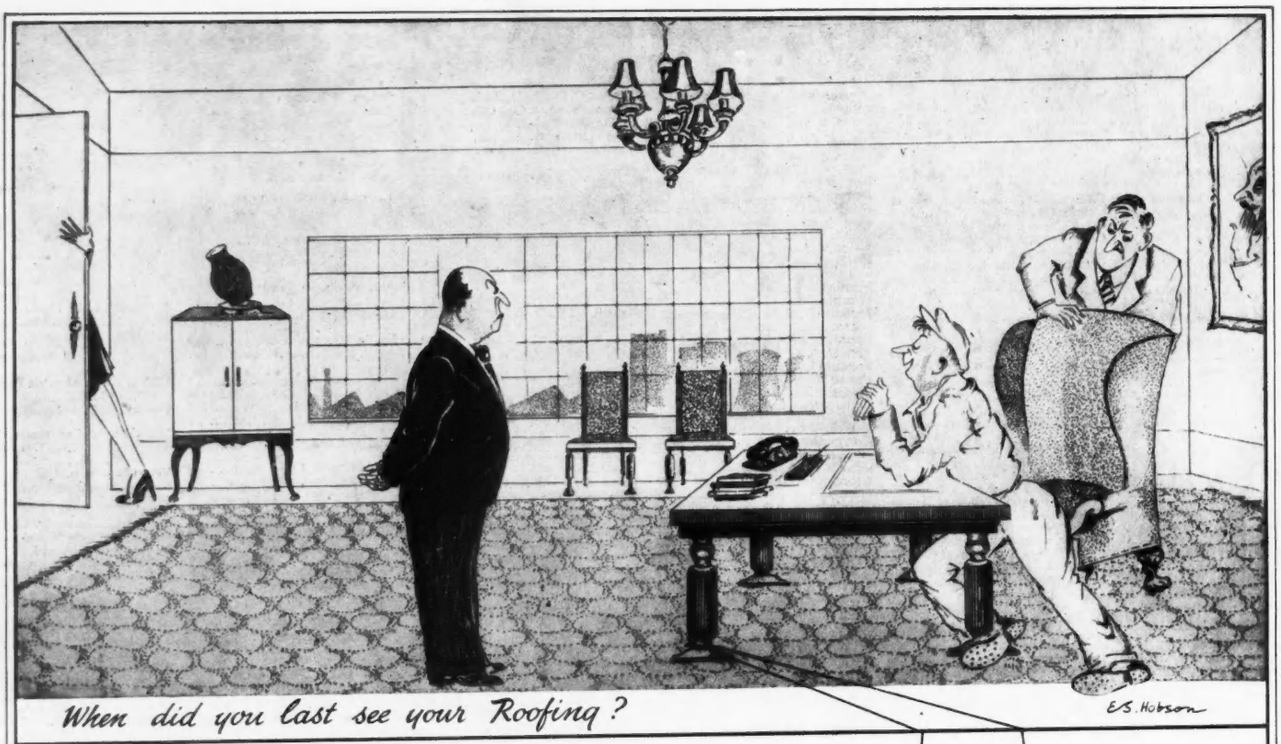

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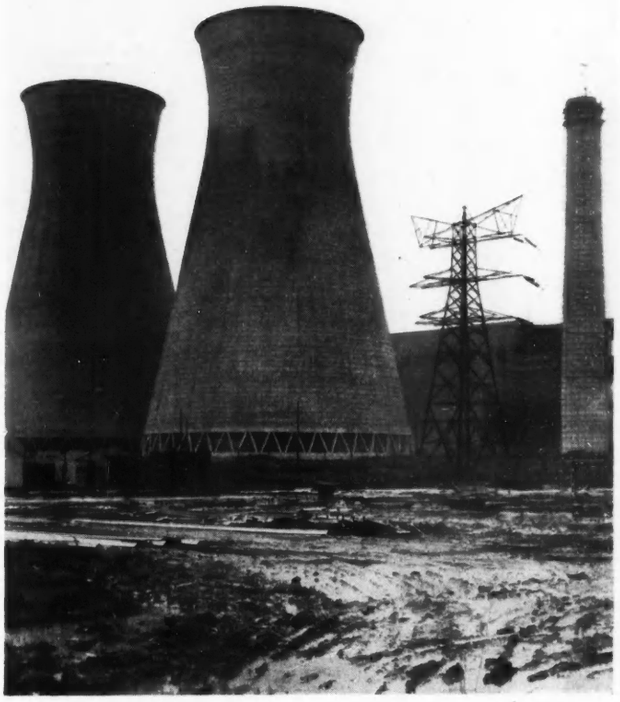

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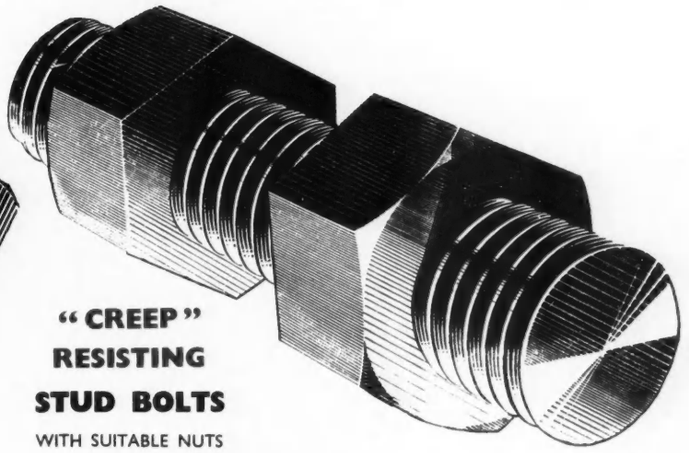

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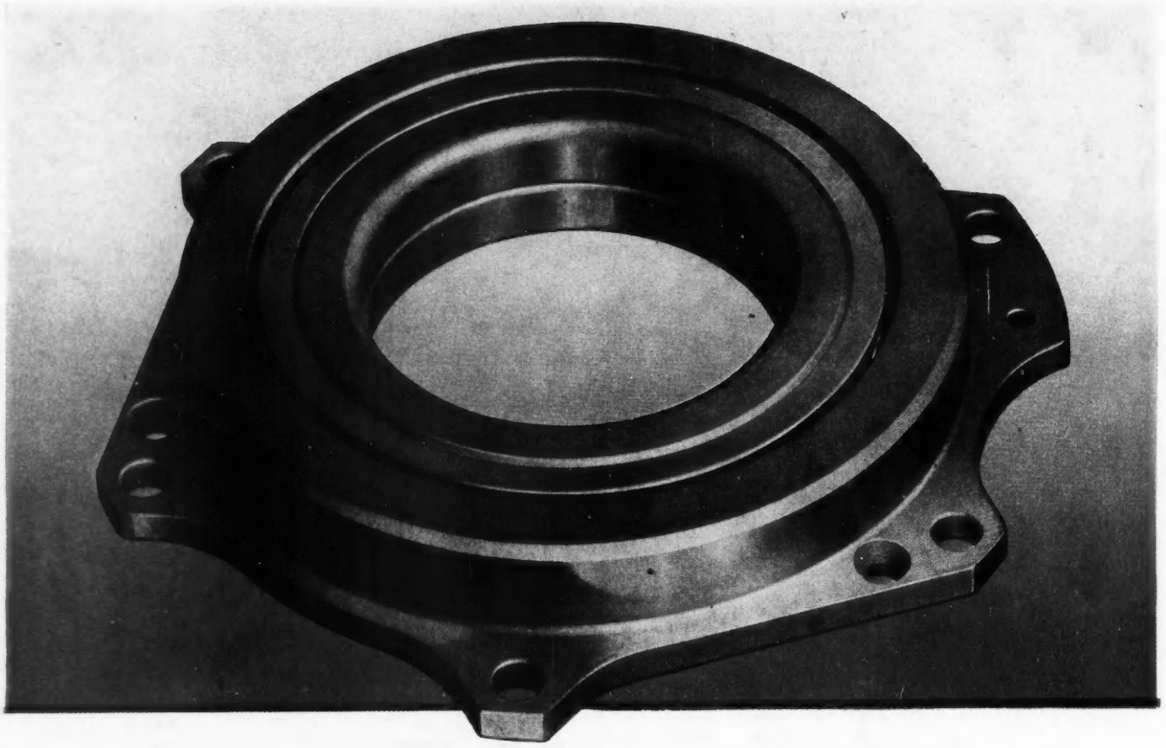

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